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Yellow-eyed Penguins (*Megadyptes antipodes*) at their nest. The male is covering two chicks three days old. Otago Peninsula, New Zealand, Nov. 24, 1957. Photo by L. E. Richdale.

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INCUBATION AND BODY TEMPERATURES  
IN THE YELLOW-EYED PENGUIN

BY DONALD S. FARNER

Although the ornithological literature now contains a substantial body of information on body temperatures and incubation temperatures, our knowledge of these for the penguins remains rather limited. Because of the divergent systematic position of this group, such data have considerable intrinsic value and interest. Of interest beyond this is the behavior of the body temperature during the protracted molt of several weeks during which there is no intake of food and water, and during incubation when there may be appreciable periods (one to five days in the Yellow-eyed Penguin) without food or water. Also of interest is the relation of the incubation temperature to the relatively long incubation periods of penguins, particularly in light of the very high degree of attentiveness.

During the spring and summer of 1953-54 I was able to obtain a series of data on the incubation and body temperatures of Yellow-eyed Penguins (*Megadyptes antipodes*) mostly in a breeding colony at Sandfly Bay on the Otago Peninsula of the South Island of New Zealand. Supplementary investigations were made at two colonies in the Catlins area, also on the South Island. The breeding colonies of this species occur on the relatively steep coastal slopes, usually within 100 meters of the shore line. The cover may vary from relatively dense bush to more open grassy slopes with clumps of New Zealand flax (*Phormium tenax*). The climate is definitely temperate, the mean temperatures for the breeding season being of the order 50-58° F. Mean rainfall is two to three inches per month during the breeding season. The life history and behavior of the Yellow-eyed Penguin have been described extensively and ably by Richdale (1941, 1949, 1951).

My data contain information on the normal range of daytime body temperature for birds ashore, the body temperature of molting birds, incubation temperature in relation to body temperature, and incubation

temperature as a function of the time of incubation. It had been hoped also that information might be obtained on the behavior of incubation temperature during periods in which a single bird incubates for several days without relief. This, however, was unsuccessful since, as Richdale (1951: 226) has previously indicated, periods of more than two days on the nest are relatively infrequent. The data which were obtained for two-day periods give no reason to suspect that there is any change under such circumstances.

#### PROCEDURES AND METHODS

Measurements of body temperature were made with previously standardized self-registering mercury thermometers. To obtain a measurement the bird was held by the legs and extended ventral side down on the ground by an assistant; the thermometer was then inserted through the cloaca to a depth of 60 mm. Although there was generally little change in the mercury column after 30 seconds, standard procedure was to maintain the insertion for one minute. The thermometer was inserted initially within 10 seconds after capture. Body temperature is here defined simply as that temperature indicated after one minute by the mercury thermometer with the bulb inserted 60 mm. through the cloaca. Obviously, as Kallir (1930) has shown so well, "body temperature" must be some such arbitrary designation.

Measurements of incubation temperature were made in eight different nests. The measurements were effected with iron-constantan thermocouples fabricated from well-insulated wire of one millimeter diameter.

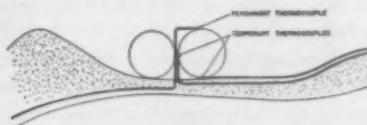


FIGURE 1. Arrangement of thermocouples and thermocouple leads for measuring incubation temperature.

One thermocouple was installed permanently in each of the nests with the leads extending to a site where the potentiometer could be attached and operated unobserved by the incubating bird. The permanent thermocouple was adjusted to a position between the uppermost surface of the egg and the ventral surface of the incubating bird. In principle, this scheme was similar to that of Barth (1949). On several occasions one or two additional temporary thermocouples were installed in order to ascertain the gradient in temperature between the upper and lower surfaces of the eggs (Fig. 1). Since the studies were being conducted

on a bird sanctuary, it was not possible to install thermocouples within eggs.

Only the actual thermocouple junction and a few millimeters of the separate wires, a total of about 15 millimeters, were uninsulated. The length of the iron and constantan leads was about eight meters. Since the use of an ice-bath reference junction proved to be impractical under field conditions, an insulated brass reference-temperature block was used (Fig. 2). Careful testing under a variety of laboratory conditions demonstrated this to be a reliable procedure. In field practice then the block temperature was recorded at the time of each measurement of potential difference. The true temperature at the site of the thermocouple was then obtained by adding the temperature indicated by the measured difference in potential to the temperature of the reference block at the time of measurement. All thermocouples were calibrated individually against a standard thermometer. Differences in potential were measured with a Leeds and Northrup portable potentiometer (No. 8667).

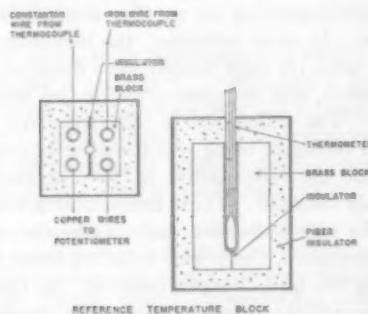


FIGURE 2. Reference temperature unit for use with thermocouples in the field.

The time of the beginning of incubation was estimated from our first observation of an incubating bird or, as was necessary in two cases, from the date of hatching. Most of the estimates are correct within two days; all are probably correct within five days. Young were hatched in three of the nests studied. No significant differences in the temperature at the interface of the egg and body surface of the incubating bird could be detected between birds incubating eggs which subsequently hatched and those with eggs which failed to hatch.

Even a most casual perusal of the literature will lead to the conclusion that the term *incubation temperature* has no uniform usage. This is to be expected since in incubation the egg has a thermal gradient between the upper surface which is in contact with the heating surface of the body of the bird and the lower surface which is in contact with the floor of the nest. This gradient is apparently in the order of 5–10° C. in several species. Naturally the important datum is the temperature of the

embryo itself (Baldwin and Kendeigh, 1932). However, there must also be a temperature gradient within the embryo as soon as it develops to an appreciable thickness. Since thermocouples could not be inserted into the eggs, the basic data obtained were measurements of the temperature at the interface of the incubating bird and the egg. It is assumed that the relation between this measurement and the actual temperatures of the embryo, or a given point within the embryo, is roughly linear, recognizing, of course, the complications of the increased size and thermogenesis of the embryo in the later stages of incubation. In this paper, *incubation temperature*, is designated as the temperature at the interface between the top surface of the egg and surface of the incubation strip of the bird.

Measurements of incubation temperature were made at intervals of two to seven days depending on weather conditions and the availability of assistance. In most instances, the incubating bird was first removed from the nest, its body temperature recorded, the permanent thermocouple adjusted, and sometimes one or two temporary thermocouples installed. The difference in electromotive force and the temperature of the reference block was recorded at intervals of two or three minutes until the temperature of the thermocouple junctions remained reasonably constant. These temperatures were then regarded as characteristic for the particular day. Once the temperature was elevated to this maximum, there was little tendency for it to change except briefly when the bird changed position. At the conclusion of a series of measurements the thermocouples were checked with respect to their positions and the temporary units removed. Usually the body temperature of the incubating bird was measured again at this time.

## RESULTS AND DISCUSSION

### *Body Temperatures*

A series of daytime body temperatures was obtained from *non-molting, non-incubating penguins* ashore in the Sandfly Bay and Catlins colonies. Only birds which could be captured without pursuit have been included in this series. These were primarily unemployed birds in the sense of Richdale (1951: 7). The mean for this series is 37.8° C. (Table 1). The importance of excluding birds obtained by pursuit is emphasized by three particular cases. On 24 March 1954 at Jack's Bay in the Catlins area, I pursued a non-molting bird for about 10 minutes. During this period, it climbed upward about 150 feet over a very steep grassy slope. The body temperature recorded immediately thereafter was 40.4° C. Another penguin taken after an upward pursuit involving 120 feet in

TABLE I  
COMPARISON OF DAYTIME BODY TEMPERATURES OF MOLTING, INCUBATING AND  
NON-MOLTING NON-INCUBATING YELLOW-EYED PENGUINS

Group	Number of Birds	Number of Measurements	Mean °C	Standard Deviation °C
Non-incubating non-molting	13	13	37.8 <sup>a</sup>	±0.43
Molting	10	20	38.6 <sup>b</sup>	±0.43
Incubating <sup>1</sup>	11	41	37.7 <sup>c</sup>	±0.56
Incubating <sup>2</sup>	10	21	38.1 <sup>d</sup>	±0.53

<sup>a</sup> Temperature measurement completed within 2 minutes after coming in sight of the bird. <sup>b</sup> Temperature measurement made after measurement of incubation temperature, 25–120 minutes after first coming in sight of the bird. <sup>c</sup> Mean 38.6° is significantly greater ( $P < 0.01$ ) than 37.8°. <sup>d</sup> Mean 38.1° is significantly greater ( $P < 0.02$ ) than 37.7°.

about 12 minutes had a body temperature of 40.2° C. On 8 April 1954 in the same locality a molting individual had a body temperature of 40.0° C. after a vigorous chase for about one minute. These differences of an order of 2° C. are consistent with differences between exercise and rest observed in other species by Baldwin and Kendeigh (1932), Udvardy (1953), Irving and Krog (1954), and Farner (1956).

This raises also the question of the effect of handling on body temperature of birds. There was actually no certain way in which this could be ascertained under the conditions of our investigations. However a brief series of data bearing on the matter should be presented. On eight occasions, involving four incubating birds, measurements were obtained beginning at the usual interval of 10 seconds or less after capture; and the birds were held then for a period sufficiently long for two additional measurements at approximately two-minute intervals. In other words measurements were completed at intervals of approximately one, three, and five minutes after capture. After holding for about three minutes, five were found to have an increased body temperature, one was unchanged, and two had lower body temperatures; the mean change was +0.1° C. which is not statistically significant. After five minutes of holding, however, the mean change was +0.7° C. although in two cases the body temperature was lower than the initial measurement. Nevertheless the difference of +0.7° C. proves to be statistically significant ( $P < 0.02$ ). Although these observations are fragmentary they appear to indicate that exercise and handling tend to elevate body temperature. They also suggest that the temperature measurement completed approximately one minute after capture is probably very close to the body temperature at the time of capture, since during an additional two minutes of holding there is on the average only a slight, statistically insignificant increase. It seems reasonable to conclude that the normal daytime body temperature for non-molting non-incubating birds ashore is very close to 37.8° C.

The data on the body temperature of molting birds also involves only individuals which could be captured without pursuit and for which the temperature measurement could be begun within ten seconds after

capture. Notations were recorded with respect to the stage of molt for each temperature measurement. However, the data do not appear to indicate any definite trend in body temperature during the course of the molt although the series is deficient with respect to the very early and terminal parts of the molt. A statistical analysis of the data (Table 1) reveals that the higher mean body temperature of the molting birds ( $38.6^{\circ}$  C., compared to  $37.8^{\circ}$  C. for non-incubating, non-molting birds, and  $37.7^{\circ}$  C. for incubating birds) is statistically highly significant ( $P < 0.01$ ) and therefore in all probability represents a true physiologic difference. Initially this appears somewhat surprising in view of the nature of the activity of the penguin during the molt period. For this period of about 24 days (Richdale, 1949:20) the bird apparently remains restricted to an area of a few square feet, unless disturbed, and obtains neither food nor water. However, this is a period of intense metabolic activity in which approximately 45% of the body weight is lost (Richdale, 1951: 284).

In obtaining data on the body temperature of *incubating birds*, there was of course the question of the effect of the activity of the investigators in setting up and adjusting the apparatus for measurement of incubation temperature. In order to ascertain the effect of this, on 16 occasions, involving 10 different incubating birds, measurements of body temperature were made immediately after first coming into sight of the incubating bird, and then again after the completion of the measurements of incubation temperature. The time period separating the two measurements varied from 25 minutes to 117 minutes. On 13 occasions there was an increase in body temperature, in one case no change, and in two cases a decrease. The mean change was  $+0.49^{\circ}$  C. which, on statistical analysis, proves to be significant ( $P < 0.01$ ). A further comparison (Table 1) of all measurements made immediately after coming into sight of the experimental bird with measurements made after the measurement of incubation temperatures shows a similar difference of  $+0.4^{\circ}$  C. and a similar statistical significance. There can be little doubt that the activity of the investigators about the nest has the effect of causing an elevation of the body temperature of the incubating bird, a point to be borne in mind in considering the data on incubation temperatures. It appears reasonable to conclude that the daytime body temperature of the incubating Yellow-eyed Penguin is about  $37.7^{\circ}$  C. and is actually no different than that of a non-molting, non-incubating bird ashore. In this respect it should be noted that Kossack's (1947) observations on Canada Geese (*Branta canadensis*) suggest that the incubating bird may have a lower body temperature (mean for two birds,  $40.6^{\circ}$  C.) than birds after incubation (mean for three,  $41.6^{\circ}$ ) and non-breeders (mean for four,

42.1° C.). Certainly this is different from the situation in Yellow-eyed Penguins. It should be noted, however, that Bernard *et al.* (1944) found the mean body temperature of 11 non-incubating Canada Geese to be 39.8° C.

Comparison of the body temperature of the Yellow-eyed Penguin with those of other penguins can be made only with considerable caution in view of the above-described influence of excitement and struggling. Unfortunately publications of investigations rarely include the methods by which the data were obtained. For the Adelie Penguin (*Pygoscelis adeliae*), a somewhat smaller species, Eklund (1942) found a mean temperature (thermometer inserted 76 mm. through the cloaca) of 39.9° C. Further reports for this species include those of Valette (1906), 40.5° C.; Andersson (1908) 37.9–40.5° C.; and Gain (1914) 39.2–39.3° C. Sapin-Jaloustre (1955) found that thermoregulation became established 15 days after hatching and that at this time the body temperature was 39.7–40.0° C. For the small Little Blue Penguin (*Eudyptula minor*), mean body temperatures of 38.5° C. and 39.0° C. have been reported by Morgan (1916). A body temperature of 38.2° C. for the large Emperor Penguin (*Aptenodytes forsteri*) has been reported by Wilson (1907) for a single bird which was pithed after catching, the body temperature being measured immediately thereafter.

#### Incubation Temperature

A striking aspect of the data on incubation temperature is the time required to attain the characteristic maximum of about 38° C. This is illustrated in Figure 3. It was either observed or assumed that the incubation period begins after the laying of the second egg, although Richdale (1951: 226) indicates that this is not necessarily the case. Since no significant differences could be noted among the data obtained from the eight nests they have been treated as a single sample. It appears probable that the relatively long "warm-up" period of about two weeks may, at least in part, account for the long incubation period (about 42 days) in this species. Although several factors may enter into this gradual development of the incubation temperature, it appears likely that most important is the increase in vascularization of the incubation patch, or more descriptively, the incubation strip. At the beginning of incubation the incubation strip is yellowish orange; thereafter it changes gradually to a reddish purple at about the end of the second week and retains this color for the remainder of the incubation period. It is true also that the birds appeared not to settle on the eggs as soon after release during the first two weeks as during the latter part of the incubation period. Since measurements were continued in each

case until a maximum sustained reading was attained, this is not likely a factor in the curve in Figure 3. Furthermore it is unlikely that this relationship can be in anyway a function of the metabolic activity of the developing embryo, for the curve for nests with eggs which failed to develop differed in no appreciable way from the curve for successful

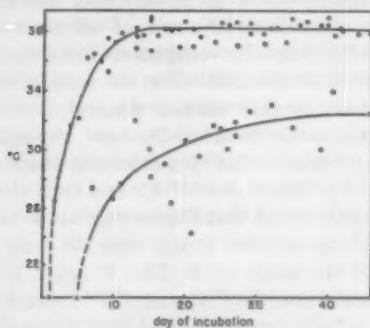


FIGURE 3. Incubation temperature through the course of the incubation period. Incubation was either observed or assumed to have begun after the laying of the second egg. Closed circles indicate the temperatures at the interface between the top of the egg and the surface of the body. Open circles represent the temperatures at the interface between the bottom of the egg and the surface of the nest. The data are from eight different nests and are treated as a single sample since no significant difference could be observed among them.

nests. Furthermore if, as in all probability it is, the pattern of increasing metabolic activity is similar to that of the developing chick embryo (Hasselbalch, 1902; Bohr, 1903; Romijn and Lokhorst, 1951), one would expect the increase in temperature much later in the incubation period. It should be noted (Fig. 4) that through the course of the incubation period the bird becomes more efficient at bringing the eggs back to normal temperature on returning to the nest. This doubtless involves, among other factors, the tendency to settle on the eggs sooner and the development of the elongated brood patch.

The gradual increase in temperature is similar to that observed by Holstein (1942, 1944, 1950) for the Goshawk (*Accipiter gentilis*), the European Sparrow Hawk (*Accipiter nisus*), and the Honey Buzzard (*Pernis apivorus*). In the case of the Goshawk, whose incubation period he found to be 41–43 days, the incubation temperature (top of the egg) was found to reach its maximum (about 41°C.) at about the 22nd day. Similarly for the Sparrow Hawk (incubation period, 39–42 days) the maximum incubation temperature (37.5°C.) was attained about the

22nd day, whereas in the Honey Buzzard (incubation period, 37–38 days) the maximum incubation temperature ( $39^{\circ}$  C.) was reached about the 11th day. These data, in addition to observations on the rate of development of the embryo, lead Holstein to the conclusion that the relatively long incubation periods of these species are the result of these preliminary periods of relatively ineffective incubation temperatures. Another case involving a gradual development of incubation temperature, according to observations of Bergman (1946), appears to be that of the Turnstone (*Arenaria interpres*). In this species (incubation period 23–26 days) incubation temperatures were found to increase from about  $30^{\circ}$  C. initially to a maximum of  $38$ – $40^{\circ}$  C. on the 18th day.

Actually there are surprisingly few observations of incubation tem-

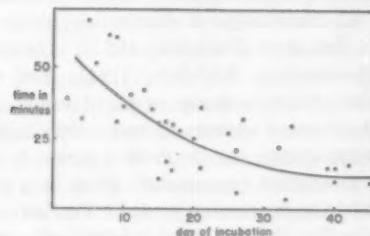


FIGURE 4. Time required to return eggs to normal incubation temperature as a function of the day of incubation. The period off the eggs in each case was between one and two minutes.

perature as a function of time during the incubation period. In the domestic fowl Burke (1925) found only very slight fluctuations ( $39.0$ – $39.2$ ) during the period between the 2nd and 20th days of incubation. An earlier series of observations by Eycleshymer (1907) indicated a mean range of  $39.7$ – $40.5$  C. for the same period. Martin and Insko (1935) found, with developing domestic turkey embryos, that the temperature of the dorsal surface of the embryo fluctuated only from  $36.5$  C. on the first to  $39.7$  C. on the 27th day. A similar situation was observed by Kossack (1947) with Canada Geese, the incubation temperature (top of the egg) increasing from  $36.5$  C. in the 2nd day to about  $39$  C. at the end of incubation.

The House Wren (*Troglodytes aedon*) is also a species in which there is apparently little change in incubation temperature through the course of the incubation period (Baldwin and Kendeigh, 1932). The temperature at the surface of the incubation patch is about  $41$  C. This temperature may be attained as early as the night following the laying

of the second egg although it is more generally attained during the night following the laying of the fourth egg of the clutch (Kendeigh, 1952). Thus the "warm-up" period which occurs during the first third of the incubation period of the Yellow-eyed Penguin (Fig. 3) has its obvious counterpart during the laying period of the House Wren. In both species the effective attentiveness (total incubation time per day) apparently remains unchanged during the course of the incubation period. However, in the case of the Yellow-eyed Penguin the effective attentiveness is greater and involves both sexes.

An obviously important variable in incubation, as shown so well by Baldwin and Kendeigh (1932) and Barth (1949), is the degree of attentiveness. In the case of the Yellow-eyed Penguin, my rather brief observations indicate that the eggs are left uncovered only for a few minutes at most, at the change of incubating birds which occurs at intervals of one to five days (Richdale, 1951). On the basis of much more extensive observations Richdale, (1941: 276) has noted that ". . . when a bird does return a change in guard occurs immediately . . ." Since effective attentiveness appears to be nearly maximum, it appears that the time required during the incubation period to attain maximum or near-maximum incubation temperature must be a primary factor in fixing the duration of the incubation period. Furthermore the available information indicates that this relationship is probably broadly applicable in birds and may well account for many of the striking differences in incubation periods.

Examination of Figure 3 shows that the incubation temperature of the Yellow-eyed Penguin is strikingly similar to actual body temperature. The data include 15 measurements after the 15th day of incubation in which body temperature was measured immediately after the measurement of incubation temperature. For these cases the mean difference between incubation and body temperature was  $-0.2^{\circ}\text{C}$ ., a difference with no statistical significance. Baldwin and Kendeigh (1932) found the temperature of the brood patch in contact with the eggs to be about  $0.7^{\circ}$  lower than body temperature in the female House Wren (*Troglodytes aedon*). The data of Kossack (1947) suggest a difference in the Canada Goose of about  $1^{\circ}\text{C}$ . at end of incubation. In the domestic goose the temperature at the interface between the surface of the bird and the egg was found to be  $39.7^{\circ}\text{C}$ . (Koch and Steinke, 1944) as compared to a body temperature of  $40.2\text{--}40.7^{\circ}\text{C}$ . (Löer, 1909, 1910; Hari, 1917; Fronda, 1921). The maximum temperatures at the interface of egg and body surface given by Barth (1949) for Willow Ptarmigan (*Lagopus lagopus*), Red-breasted Merganser (*Mergus serrator*), Lesser Black-backed Gull (*Larus fuscus*), Mew (Common) Gull (*Larus canus*), and Common Tern

(*Sterna hirundo*), and by Holstein (1950) for the Goshawk must be very close to actual body temperatures. It must be emphasized however (Baldwin and Kendeigh, 1932; Huggins, 1941) that the actual temperature of the embryo is somewhat lower.

From the comparisons cited above it appears that the incubation of the Yellow-eyed Penguin, in relation to body temperature, is not strikingly different from other species. I am unable to find in the literature any comparable data for other species of penguins. For the Emperor Penguin, the mean egg temperatures of 26.6–33.9° C. reported by Etchécopar and Prévost (1954) (see also Prévost, 1955) were obtained by inserting thermometers into the eggs. There appears to be no way of effecting a useful comparison between their data and mine.

It is of interest to compare the temperature gradient between the top and bottom of the egg in various species when the incubating bird is maintaining maximum or near maximum incubation temperature. In the Yellow-eyed Penguin (Fig. 3) this gradient appears to decrease through the course of the incubation period being in the order of 5–8° during the last half of the period. In the domestic fowl (Burke, 1925) the gradient is of the order 7–9° C., the smaller gradient occurring during the latter half of the period. Koch and Steinke (1944) have reported an 8° C. gradient for the domestic goose, whereas Barth's (1949) data indicated 9° C. for the Willow Ptarmigan (*Lagopus lagopus*), 9° C. for the Lesser Black-backed Gull (*Larus fuscus*), and 14° for the Common Tern (*Sterna hirundo*). The data of Baldwin and Kendeigh (1932) suggest that the gradient is about 9° C. for the House Wren. Here again the Yellow-eyed Penguin, although attaining a low gradient in the latter part of the incubation period, does not differ substantially from other species.

#### ACKNOWLEDGMENTS

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#### SUMMARY

1. Body temperatures of Yellow-eyed Penguins were measured by insertion of a self-recording thermometer 60 mm. through cloaca for one minute. The mean body temperature for non-incubating non-molting birds ashore was found to be about  $37.8^{\circ}$  C. ( $100.0^{\circ}$  F.). The temperature for molting birds ( $38.6^{\circ}$  C.,  $101.5^{\circ}$  F.) was significantly higher. The body temperature of previously undisturbed incubating birds ( $37.7^{\circ}$  C.,  $99.8^{\circ}$  F.) is not significantly different from that of non-molting non-incubating birds. The presence of a person near the nest causes a significant increase (about  $0.4^{\circ}$  C.,  $0.7^{\circ}$  F.) in the body temperature of the incubating bird.
2. Incubation temperature (*i.e.* the temperature at the interface between the incubation strip and the surface of the egg), as measured with iron-constantan thermocouples, increased gradually (Fig. 3) from  $20\text{--}25^{\circ}$  C. ( $68\text{--}77^{\circ}$  F.) during the first two days to a maximum of about  $38^{\circ}$  C. ( $100.4^{\circ}$  F.) at 15 days; this maximum was maintained throughout the remainder of the incubation period. The period of increasing incubation temperature coincides with a period of increased vascularization of the incubation strip.
3. The maximum incubation temperature, which occurred generally from the 15th day to the end of incubation, was found not to differ significantly from the body temperature of the incubating birds.
4. There is a gradual decrease in the gradient between the upper and lower surfaces of the egg to a level of about  $5\text{--}8^{\circ}$  C. ( $41\text{--}46^{\circ}$  F.) during latter half of the incubation period (Fig. 3).

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ANTICIPATORY FOOD-BRINGING IN THE  
PRAIRIE WARBLER

VAL NOLAN JR.

ALTHOUGH it is a commonplace that males of many species of birds feed females engaged in incubation, there are also occasional references (Hann, 1937; Sargent, 1940; Nice, 1943) to males whose behavior has suggested that they were carrying food not to their mates but to their anticipated nestlings, in eggs as yet unhatched. It remained for Skutch (1953) to provide an explanation which removes such premature solicitude from the category of the aberrational, and to suggest that impatience to feed young leads males of some species to make anticipatory visits to the nest with food; when only the female incubates, this behavior is useful in bringing about the male's prompt awareness of hatching and his early attention to the needs of nestlings. It is the purpose of this paper to describe and discuss 34 acts of anticipatory food-bringing by male Prairie Warblers (*Dendroica discolor discolor*), to review that and similar behavior attributed to other wood warblers, and to comment on the psychological basis of this food-bringing and its place in the evolution of what is believed to be related behavior.

## METHOD AND LOCALITY OF STUDY

Study of the Prairie Warbler near Bloomington, Indiana, began in 1952 (Nolan, 1955). Nest life was investigated most intensively in 1956 and 1957, when dawn-to-dark observations of single nests were made on 25 occasions distributed among 12 nests of nine pairs, six of them color-banded. (I exclude watches at nests incubated by females which had been deserted by their mates and at nests at which incubation had either not yet been begun or had been completed.) The time-advance of incubation was known exactly in every case. Five of the 25 days were those on which young began to emerge from the eggs, "hatching days," and the remaining "incubation days" were divided, as evenly as predators permitted, among the first, a middle, and the last full day of the incubation period. Because events at the nest on hatching day are of particular interest and involve special inquiries, the five hatching days are for the most part given separate treatment herein.

## PREVALENCE OF ANTICIPATORY FOOD-BRINGING

During the 25 all-day watches, anticipatory food-bringing was noted 20 times on incubation days and three times before the emergence of the first nestling on hatching days; in addition, 11 other instances were witnessed during briefer and less systematic watches conducted through-

out the study. Thirteen males were seen engaging in the behavior under discussion. The one male, of those whose nests were observed in day-long watches, that was never seen to take food to eggs was a bird whose nest was studied only once; and on that day he was feeding fledglings of a first brood while his second-brood eggs were being incubated. As will appear below, this was not the only all-day incubation watch during which a male brought no food, but all the males in the other cases performed the act on some earlier or later occasion.

*Age of Males.* Because nestling Prairie Warblers produced on the study area very rarely returned to breed there, I have no instance of anticipatory food-bringing by a bird of known age. However, other facts support the proposition that young males without previous experience in feeding nevertheless carry food in anticipation of young. Ten of the 13 males in which the behavior was seen had been under daily study from the times of their arrivals; nine quite certainly had had no earlier nests that season and hence had not fed nestlings during the same summers in which the anticipatory food-bringing was observed; one had fed young in an earlier nest. Data on longevity and on the annual turn-over among breeding adults are still incomplete, but they indicate the very great probability that some among these nine were one-year-olds whose "anticipation" cannot have been founded on the experience of feeding young. One male, studied in both 1956 and 1957, in the former year took food to eggs which ultimately produced fledglings. He did not carry to the eggs in his mate's first nest next year, on the first day of incubation, but 18 days later he did engage in food-bringing when the female began to incubate at the third nest.

#### ANTICIPATORY FOOD-BRINGING AND ITS RELATION TO ACTIVITY OF FEMALE

Only the female Prairie Warbler incubates, and her departures from the nest during incubation cannot be correlated with signal songs by the male or with other behavior by him. Except as described in this paper, in extensive field work throughout the Prairie Warbler's period on the breeding area, I have never seen a male feed a female or deliver food to her except manifestly to be relayed to nestlings. Rarely, if it is persistently rejected by them, the female will eat the food.

Anticipatory food-bringing occurs largely or wholly without regard to whether the female happens to be on her nest at the time. Of the 32 occasions when food was taken to an active nest, seven were during female inattentive periods. That is, she was incubating on 78.2 percent of the male's visits, a figure so close to the proportion of time spent covering eggs as to indicate that chance determines whether the female

will be present at her mate's arrival. The existence of a nest and eggs is, of course, part of the general situation in which the male's impulse to bring food rises to the level of action, but the eggs and even the nest may exist only in memory or in prospect. One male spent 30 seconds offering a caterpillar to the spot from which I had 24 hours earlier removed the nest, three hours after a snake had caused the female to desert. A second male persisted in thrusting a larva into a nest which had succumbed to a predator four or five hours beforehand.

Behavior of the male in anticipatory food-bringing varies little and does not differ from that preceding true feeding. A single item is brought, as is usually the case when newly hatched nestlings are fed. It is possible that food chosen is slightly larger than that given to very young birds; if this is true, perhaps the male must learn from experience what sizes are acceptable. Holding the food in his bill, he ordinarily announces his arrival by singing while still some 10 to 30 yards away. Song may be repeated for two or three minutes as he gradually draws closer, finally to light a foot or so from the nest. Hopping to the rim, he proffers the food, bending forward some five or six times and persisting for an average of 30 seconds or so. Occasionally he moves a few inches away, then returns once or twice to try again from a different perch. If the female is absent, his thrusts seem oriented toward the center of the cavity, probably toward the eggs resting there. Even if she is present, he only rarely extends the food toward her head or bill; more often, standing beside or behind her he tenders it to a spot occupied by the middle of her back, and I once thought he tried to poke it down between the side of the nest and his mate's wing. These male-female encounters at the nest are silent.

Disposition of the food is often difficult or impossible to observe, both because the male leaves rather suddenly and because his position on the rim may screen his head from view. In the absence of females, males ate the food at least four times and carried it away at least two. Females were seen to receive and eat food seven times, while on seven other occasions the males ate it or left with it when their mates were present. It is clear that acceptance by the female does not stimulate the male to further efforts. Although he may bring food more than once a day, occurrence of a second visit cannot be related to any observable peculiarity of the first.

Female reaction to anticipatory food-bringing, as the foregoing statements will have suggested, ordinarily appeared to be one of complete indifference. Frequently she never looked at the male, and even when she ate the food she took it only after lapses of as long as two minutes. Twice females returned to their nests shortly after males

arrived, but these cases may have been merely coincidental since in both the females had been away for normal inattentive periods. Each of three other reactions was observed once: A female rose in the nest as though to uncover the cavity, another got to the rim beside the male, and a third left the nest the instant he lit on the rim. All these are quite common forms of behavior after the eggs have hatched, so that it would seem that anticipatory food-bringing by the male is occasionally the stimulus for a suitable but equally anticipatory response by his mate. Indeed, her acceptance of the food may belong in this category, for much that the male brings to the nestlings is taken from him and distributed by the female.

#### TIME OF ANTICIPATORY FOOD-BRINGING

The incidence of the activity throughout the day is shown in Table 1, in which the Prairie Warbler's waking day has been divided into five intervals of three hours each, beginning at 0415 hours, central standard time, and ending 15 hours later at 1915. In column A are the 20 instances from the 20 incubation watches, while column B shows all 34 instances. The data in B are distorted by the unequal distribution of total field hours among different times of day. Both columns reveal a high proportion of anticipatory food-bringing in the three hours following dawn, when song and feeding of young are also at a peak, and column A indicates that food-bringing, like these latter activities, wanes from mid- or late morning until mid- or late afternoon. Seven acts were performed by one male and six each by two males; no pattern or schedule can be discerned in the timing of an individual bird's visits.

TABLE 1  
HOURLY DISTRIBUTION OF ANTICIPATORY FOOD-BRINGING

	<i>A. All-day watches</i>	<i>B. All instances</i>
0415-0715	9	13
0715-1015	2	9
1015-1315	1	3
1315-1615	5	5
1615-1915	3	4

Of the 20 incubation day watches there were nine when anticipatory food-bringing occurred once during the day, four when it occurred twice, one three times, and six not at all. The single day on which there were three visits was one immediately preceding hatching, but nothing else suggests an increase as hatching approaches. There was no correlation between the dates and either the time of visits or their number.

The earliest all-day incubation watch was on May 10 and the latest on July 16. These were the extreme dates of incubation in 1956 and 1957 by females whose mates were still on territory; a deserted female incubated until July 18. Table 2, in which the "incubation season" has been divided arbitrarily into five periods of two weeks each, indicates that after an initial interval when it is rare or absent anticipatory food-bringing is performed with considerable regularity as long as the pair bond lasts. It will be recalled that I earlier excluded all incubation watches at nests deserted by the males. If four such watches between June 22 and July 18 were included in Table 2, it would then show a late season decline in food-bringing by the male population as a whole, corresponding to the general regression in reproductive activity that is observable at that time.

TABLE 2  
DISTRIBUTION OF ANTICIPATORY FOOD-BRINGING BY DATE

	Number of watches	Watches without food-bringing
May 10-May 23	3	3
May 24-June 6	6	1
June 7-June 20	4	0
June 21-July 4	2	1
July 5-July 18	5	1

#### PSYCHOLOGICAL BASIS OF ANTICIPATORY FOOD-BRINGING

Before seeking a theoretical explanation for anticipatory food-bringing, the possible influence of three factors will be considered:

1) *Time-advance of the incubation period.* The stage of incubation appears to have little bearing on the occurrence of food-bringing. One male carried food to the nest on the day before the last egg was laid, i.e., before the female had settled down to regular attentiveness. Eight nests were watched throughout the first full day of incubation, and the males brought food to five of these. The three to which they did not were the three shown in Table 2 as falling in Period 1, so that the significant point was not time-advance but some factor more closely connected with progress of the season.

2) *Weather.* Within the extremes occurring during the study, weather cannot be established as affecting the behavior in question. A number of instances of food-bringing were seen on days of steady rain, and cloud cover and temperature were without perceptible influence. All the watches in Period 1, when anticipatory food-bringing was not witnessed, took place on sunny days. The lowest mean temperature on any of these three days was 60° and the highest 71°, while anticipatory food-bringing was seen on June 3, 1956, the mean tem-

perature of which was only 54°. The unimportance of temperature at the moment of carrying is confirmed by the high percentage of the acts during the early hours of the day.

3) *Level of male attentiveness.* It seems safe to conclude that anticipatory food-bringing is what it looks like, a manifestation of male attentiveness, and this makes relevant a general inquiry into the level of his attentive behavior in May. The best measure, before the eggs hatch, of the proportion of time devoted to activity associated with reproduction rather than to self-maintenance is the frequency and incidence of song throughout the day. Song counts of mated males reveal no significant differences in early, middle, and late May. Also, male interest in the nest-building by the female seems to reach full intensity at the very beginning of construction, at about the end of April.

It is clear that a fundamental explanation of, or theoretical basis for, anticipatory food-bringing must take account of facts and probabilities which may be summarized as follows: Most male Prairie Warblers, including those without previous breeding experience, carry food to incubated nests before there are young to eat it. They do this once or twice a day, seldom more often, from the beginning of incubation onward, at an hour which for any individual male cannot be predicted from day to day; and their performance is unaffected by whether the female is present or whether she accepts the food or rejects it. Anticipatory food-bringing occurs at all hours, its frequency following about the same curve as do song and other male attentive behavior, but it is rare or absent early in the nesting season despite other indications of a high intensity of reproductive drive at that time. Among males that remain mated, food-bringing is regular from late May until females cease to incubate in mid-July.

All these facts and probabilities assume order and coherence when viewed in the light of Lorenz' (1950) theory of action specific energy and vacuum activity, to which Skutch's (1953) "impatience" is presumably akin. It is not within my competence to examine the validity of the theory, and I propose only that it provides for anticipatory food-bringing a conceptual framework consistent with the facts observed by the field investigator. A recent statement of the Lorenzian view is taken from Thorpe (1956: 18-19): Given innate or instinctive fixed action patterns, there "tends to build up a kind of specific tension in the central nervous system, and if the animal does not find itself in the appropriate situation for the action pattern to be released, this specific action potential is, as it were, dammed up. The damming-up process results in a lowering of the threshold for the stimuli effective in releasing that particular action pattern. Indeed, if continued long

enough, the tension may accumulate to the point at which the action pattern goes off without any external stimulus at all, . . . giving rise to what is called vacuum activity. . . ." The specific readiness is reduced and may disappear when the consummatory act of the charged instinct takes place.

A chief merit of this explanation is that it accounts for the curious mixture of the unpredictable and the patterned, the random and the planned, that characterizes anticipatory food-bringing. It makes understandable the carrying of food to a nest no longer in existence (a more nearly perfect vacuum activity), and it becomes a matter of course that eggs of a second brood would receive no attention while fledglings are being fed.

#### PROBABLE FUNCTION AND VALUE OF THE BEHAVIOR

Five nests were studied on hatching day. It will be seen from Table 3 that at least three hours elapsed after the first nestling emerged before any male fed the young. While males 2 and 4 made anticipatory

TABLE 3  
MALE FOOD-BRINGING ON HATCHING DAY

Nest	Visits before hatching	Time of first hatching	Feedings	Minutes from hatching to first feeding or night
1	0	1333	9	183
2	1	1425	0	300
3	0	0520	30	325
4	2	1022	0	528
5	0	before 0400	15	598

visits early in the day, they failed to feed during the five and nearly nine hours, respectively, that remained between hatching and the females' retirement at night. During the nine hours at nest 4 the female made 30 trips with food, some of it quite surely gathered and carried while her mate was looking toward her. Contrast the events at nest 3: In five and one-half hours following hatching the female fed young six times. At 10:45 the male first brought food, which a nestling accepted. The male immediately darted away a few feet but returned to the rim to look into the nest for five seconds. Again he started to leave and again returned. He then flew 10 yards away, caught an insect, and promptly delivered it to a nestling. Once more he did this, so quickly that he had fed three times within one and one-half minutes of his first appearance at the nest. In the 15 minutes beginning with the first feeding, six trips with food were made, and between the first feeding and dark this male fed 29 times. The story told by the events at nests 1 and 5 is somewhat less dramatic but it differs only in degree.

Data from these five nests seem to give almost conclusive support to the statement that anticipatory food-bringing is a device by which the male Prairie Warbler learns of the hatching of the eggs. Although he occasionally goes to the nest without food and sometimes accompanies his mate more or less closely on her return at the end of an inattentive period, these activities (which occur without reference to the stage of incubation) do not together equal anticipatory food-bringing in their frequency; and it seems probable that they are, at most, relatively unimportant means of discovery. I have seen nothing to suggest an attempt by the female to communicate the fact of hatching and certainly have witnessed nothing to raise an inference that the male was responding either to a signal or to the female's food-carrying.

The advantages of early discovery and participation in the care of nestlings may be presumed to be the same as the advantages accruing to those altricial species in which the male helps feed the young, as opposed to those in which he does not help. Brood sizes can be larger, and since the female can rely at least to some extent on the male to feed the nestlings while she shelters or warms them, more rigorous weather can be endured.

That anticipatory food-bringing helps confer these benefits on the Prairie Warbler is indicated by a comparison of additional data gathered at nest 1, where the male was quick to assist his mate, and at nest 4, where he fed no sooner than about mid-day on the day after hatching day. Hatching days at these two nests were within one day of being a year apart, and weather conditions at the relevant times were indistinguishable. There was a difference of only nine inches in nest heights, but nest 1 was exposed to direct sunlight in the early afternoon, while nest 4 was in shadow all day. Table 4 shows to what extent and by which parent the nestling requirements of food and shelter were met at nests 1 and 4. The degree of protection from the weather is presented by standard attentive and inattentive data on brooding, modified only in that the first attentive period, during which the initial hatching occurred, is taken as having begun at the time of hatching and not at the time the female returned to the nest. To derive the rate of feeding per young on a day when the number of young undergoes change as the result of successive hatchings, I have used the unit "nestling minutes." This term designates the aggregate of the numbers of minutes between the time each egg hatched and the time at which the female went to the nest to brood for the night. The rate of feeding is determined by dividing the nestling minutes by the number of feedings. No differences were detected in the quantity or quality of items per feeding, and those factors are assumed to have been constant.

TABLE 4  
SATISFACTION OF REQUIREMENTS OF NEWLY-HATCHED YOUNG

	<i>Nest 1, 4 young, in sun, male feeding</i>	<i>Nest 4, 3 young, in shade, male not feeding</i>
Minutes from first hatching till night	329	528
Attentive periods	14	29
average length, minutes	20.4	14
extremes, minutes	113-1	39-4
percent of total time	86.9	76.9
Inattentive periods	14	29
average length, minutes	3.1	4.2
extremes, minutes	10-1	14-1
percent of total time	13.1	23.1
Nestling minutes	558	727
Feedings by female	12	30
Feedings by male	9	0
Rate of feeding per nestling	26.5	24.2

It is apparent from Table 4 that female 1 gave shelter to her young during 10 percent more of the first hours of their lives than did female 4, and this without sacrificing their food needs, which male 1 helped satisfy. The difference in time on the nest was accounted for by an uninterrupted interval of nearly two hours during which female 1 stood over the cavity and shaded her eggs and her first nestling from the direct rays of the mid-June sun. As it happened, the location of female 4's nest was such that she did not confront the necessity of choosing between shelter and food, nor is it clear what limitations are imposed on that choice by the nestlings' constitutions. However, exposure to direct sun, to rain, and to cool temperatures would be quite common risks for young in many Prairie Warbler nests near Bloomington, if the male's attentiveness did not afford the female a certain latitude to adjust her own behavior to guard against these dangers.

Consideration of the events at nests 1 and 4 during four and one-half hours on the first morning after hatching day is equally revealing. The two females spent nearly identical percentages of time on the nests. Female 4, still unassisted, fed 15 times and female 1, 13. But because male 1 made 11 trips with food, the nestlings in nest 1 were fed at a rate of once every 45 minutes while those in nest 4 averaged once each 54 minutes. The significance of this comparative slowness in female 4's feeding rate per bird will assume its true proportion when it is emphasized that she had only three young to feed, while in spite of their greater number (four) the nestlings in nest 1 were each getting more to eat.

Lest the advantages to the Prairie Warbler of the male's assisting in feeding be overestimated, it is acknowledged that heat and shelter become decreasingly significant as the nestling period advances. Further, there is good evidence that an unassisted female is well able to supply the food requirements of her young. As an example, a male and female made a combined total of 82 trips to feed three nestlings during their ninth day of life, while three days later at a nest a few hundred yards away a female deserted by her mate fed three nine-day-old young 98 times. No appreciable differences in kind or quantity of food were noted, and both broods succeeded. Finally, in weighing the advantages of anticipatory food-bringing, its effect on the Brown-headed Cowbird (*Molothrus ater*) must be considered. The cowbird was a frequent brood parasite on the study area, and its egg or eggs invariably hatched before those of this host. I have seen male warblers feeding cowbird nestlings before their own eggs had hatched, and this doubtless contributed to the usual quick starvation of the young warblers.

#### FOOD-BRINGING AND RELATED BEHAVIOR IN MALES OF OTHER WARBLERS

The Appendix discloses that in addition to the Prairie Warbler male wood warblers of 20 species from 11 of the 25 genera in the family have been recorded as feeding the female, or carrying food to the nest, prior to the hatching of eggs. Nine of the 17 North American genera are represented on the list, and eight of the 17 North American species in the tabulation belong to the genus *Dendroica*. Included as a "species" is a hybrid male *Vermivora pinus* x *chrysoptera*. Also counted is the Kentucky Warbler (*Oporornis formosus*), in which feeding has been seen performed only by a second or "helper" male.

Although Lack (1940) and Armstrong (1947) state that species are rare in which the delivery of food to females occurs only during incubation, no more than four of the wood warblers have been said to engage in courtship as opposed to incubation feeding. Mousley (1928) in many hours of observation at a number of Parula Warbler (*Parula americana*) nests once saw a male feed a female as she built. The male Olive Warbler (*Peucedramus taeniatus*) feeds his mate occasionally during nest-building and incubation (Willard, 1910; Skutch, in Griscom and Sprunt, 1957). Skutch reported that the male Buff-rumped Warbler (*Basileuterus fulvicauda*) delivers food during courtship (1953), although in his subsequent life history of that species (1954) and in his most recent publication on it (in Griscom and Sprunt, 1957) he has spoken only of incubation feeding. Courtship feeding may occur occasionally in the Yellow Warbler (*Dendroica petechia*), a spe-

cies in which also feeding of the female on the nest is highly developed. Linsdale (1938: 120) saw a female Yellow Warbler "twittering and waving its wings," after which the male apparently fed her. Not far away was a nest with three eggs, to which a fourth was added next day. Since the female Yellow Warbler sometimes begins to incubate before the last egg is laid (Smith, 1943; Kendeigh, 1952), and since Mousley (1926) in one instance saw a male feed his mate as she came off the nest late in the incubation period, Linsdale's observation does not fit neatly into either the category of courtship or that of incubation feeding.

Eighteen male wood warblers have been reported to feed the females during incubation, as shown in the Appendix. In most cases the act takes place at the nest and probably not so frequently as to furnish the female with much sustenance, but there are important exceptions to both of these generalizations. The male Yellow Warbler brings food in such quantity that his mate's attentive behavior has been modified, and she has been found to cover the eggs 91.9 percent of the time (Kendeigh, 1952). The Bay-breasted (*Dendroica castanea*), occasionally the Yellow, and perhaps the Chestnut-sided (*D. pensylvanica*) females receive food from the males away from the nest (as well as on it), as does the Kirtland's Warbler (*D. kirtlandii*). In the last species the female ordinarily leaves to accept the food, fluttering her wings like a young bird as she takes it; as incubation progresses the male sometimes feeds her on the nest (Van Tyne in Bent, 1953).

Anticipatory food-bringing has been recognized as such (Skutch, 1953; 1954; in Griscom and Sprunt, 1957) only in the Buff-rumped, Pink-headed (*Ergaticus versicolor*), and Crescent-chested Warblers (*Vermivora superciliosa*) (but query the sufficiency of the reported evidence in the last species). Hann (1937) tells of several instances of premature food-bringing by a male Ovenbird (*Seiurus aurocapillus*), but the female was in the nest and the disposition of the items was not seen. In addition to these species, anticipatory visits may well have been mistaken for incubation feeding when seen only once or twice in the warblers listed in the Appendix as incubation feeders. One case is especially interesting: Sturin (1945: 197) reports a male American Redstart (*Setophaga ruticilla*) which fed the female on the nest 15 times, from one to three times a day. "More frequently, however, the female reacted to the male differently when he came to the nest with food. On twenty-six occasions she flew away at his approach. He did not remain long at the nest after she left, but ate the food and flew away." The fact that all the visits were initiated while the female was on the nest requires explanation, but it is not necessarily inconsistent with the probability that the male was anticipating his nestlings.

The difficulty of distinguishing, on the basis of a few observations, between occasional or casual feeding of the female and the premature bringing of food for young calls attention to the point, noted by Skutch (1953), that these two activities are alike in function. It seems probable that they are part of the same development, and that anticipatory food-bringing is the earlier stage in evolution. Perpetuated because it readies the male to feed young, his premature visit can, with no additional drain on his energies, acquire further value if the female eats the food he brings. This occasional incubation feeding cannot make any great contribution to the female's nourishment, and its force in maintaining the bond between the pair can only be conjectured. It is, however, a plastic bit of behavioral material which the forces of selection can mold. In the Yellow Warbler it is the physical or nutritional aspect of the feeding which appears to have become important, a fact which is objectively measurable. On the other hand, in species in which feeding during incubation has been dissociated from the nest so that the female is given food although she is free to gather it for herself, it would seem that the act has acquired a more imponderable function, presumably associated with the stability of the pair. This "symbolic" content might be expected to become more pronounced in further development; once feeding has been disengaged from the nest, its projection back to an earlier stage of the reproductive cycle in which there is no nest seems but a step.

Certainly the behavior of the wood warblers lends no support to the belief that "courtship feeding did not arise from the habit of feeding the incubating mate but vice versa" (Armstrong, 1947: 44). Lack (1940: 174) has pointed out that courtship feeding "has almost certainly originated several times independently," and he and Noble and Wurm (1943) have proposed a sequence in which parental behavior is the basis from which some courtship feeding evolved. Do not the views presented in this paper suggest the answer, for some species, to Lack's question—why, in courtship feeding, is it the male that almost invariably feeds the female?

It is unnecessary to propose, as Mrs. Nice (1941) reports G. Steinbacher (Ber. Verein Schles. Ornith., 23: 42–64, 1938) to have done, that the *function* of courtship feeding is to prepare the male to feed nestlings, but on the evidence of the wood warblers it seems probable that anticipatory food-bringing, which does so function, was one of the *origins* of courtship feeding.

#### ACKNOWLEDGMENTS

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#### SUMMARY

The male Prairie Warbler carries food from one to three times a day throughout the incubation period, taking it to the nest without regard to whether the female is present and apparently deriving no satisfaction if she accepts it, as she sometimes does. Analysis of 34 such acts by 13 males indicates that food-bringing is probably performed by first-year as well as older birds, is not affected by normal extremes of weather, is most frequent in the early morning and late afternoon, and is rare or absent during the first two weeks of the species' nesting period.

Observations at five nests on the hatching day tend to prove that the male is unaware of hatching until he makes a food-bringing visit and that the behavior therefore functions to bring about the discovery and prompt feeding of the young by the male. Comparison of events at a nest at which the male discovered his young quickly and at a nest at which he did not suggests that his early assistance in feeding permits the female to adjust her brooding schedule to weather conditions without sacrificing the nourishment of the nestlings. In favorable weather the advantage takes the form of a more rapid feeding rate, which should be conducive to the raising of larger broods.

Anticipatory food-bringing is regarded as a vacuum activity within the theory of Lorenz. A review of the 20 other species of wood warblers in which the male is reported to carry food or to feed the female before there are nestlings leads to the view that incubation feeding in this family has evolved from anticipatory food-bringing and that courtship feeding in three or four Parulids is but a later stage in evolutionary development.

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## APPENDIX

## OTHER PARULIDS IN WHICH MALES FEED FEMALES OR CAREY FOOD

<i>Species</i>	<i>Kind of feeding and place</i>	<i>Authority</i>
<i>Prothonotaria citrea</i>	Incubation, on nest	Walkinshaw (1938; 1953; in Bent, 1953; in Griscom and Sprunt, 1957)
Hybrid, "Brewster's" Warbler	Incubation, on nest	Carter (1944)
<i>Vermivora pinus x chrysopatra</i>	Incubation, on nest	Knight (1908); Bent (1953)
Nashville Warbler	Incubation, on nest	Skutch (1953; 1954)
<i>Vermivora ruficapilla</i>	Anticipatory, to nest	Mousley (1928)
Crescent-cheeked (Hartlaub's) Warbler	Courtship, at nest during building	Willard (1910); Skutch (in Griscom and Sprunt, 1957)
<i>Vermivora superciliosa</i>	Courtship, away from nest during building; incubation, on nest	Linsdale (1938)
Parula Warbler	Courtship (?), away from nest	Mousley (1926)
<i>Parula americana</i>	Incubation, on and off nest	Gabrielson (1922); Schrantz (1943); Kendeigh (1952); Bent (1953)
Olive Warbler	Incubation, on nest	Harding (1931)
<i>Pseudoramphus fuscatus</i>	Incubation, on nest	Lawrence (1953)
Yellow Warbler	Incubation, on nest	Sawyer (1947)
<i>Dendroica petechia</i>		
Black-throated Blue Warbler		
<i>Dendroica caeruleiceps</i>		
Blackburnian Warbler		
<i>Dendroica fusca</i>		
Chestnut-sided Warbler		
<i>Dendroica pensylvanica</i>		

<i>Species</i>	<i>Kind of feeding and place</i>	<i>Authority</i>
Bay-breasted Warbler <i>Dendroica castanea</i>	Incubation, on and off nest	Oberholser (in Griscom and Sprunt, 1957)
	Incubation, on nest	Stanwood (1909); Mendall (1937); Bent (1933)
Blackpoll Warbler <i>Dendroica striata</i>	Incubation, on nest	Gross (in Bent, 1953)
Pine Warbler <i>Dendroica pinus</i>	Incubation, on nest	Nice (1931)
Kirtland's Warbler <i>Dendroica kirtlandii</i>	Incubation, on and off nest	Van Tyne (in Bent, 1953; in Griscom and Sprunt, 1957)
Ovenbird <i>Seiurus aurocapillus</i>	Anticipatory or incubation, on nest	Hann (1937)
Kentucky Warbler <i>Oporornis formosus</i>	Incubation, on nest	Gross (in Bent, 1953)
Yellowthroat <i>Geothlypis trichas</i>	Incubation, on nest	De Garis (1936)
American Redstart <i>Setophaga ruticilla</i>	Anticipatory or incubation, on nest	Gross (in Bent, 1953)
	Incubation, on nest	Sturm (1945)
Pink-headed Warbler <i>Erythrocercus variabilis</i>	Anticipatory and incubation, on nest	Gabrielson (1922); Baker (1944); Gross (in Bent, 1953); Cruicksank (in Griscom and Sprunt, 1957)
Buff-rumped Warbler <i>Bastardierus fulviventer</i>	Courtship; anticipatory and incubation on nest	Skutch (1953)
	Anticipatory, to nest; incubation, on and off nest	Skutch (1954; in Griscom and Sprunt, 1957)



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PLATE 12



LAWRENCE EMERSON HICKS

## IN MEMORIAM: LAWRENCE EMERSON HICKS

BY EDWARD S. THOMAS

THE death on January 20, 1957 of Lawrence Hicks, Fellow and past Secretary of The American Ornithologists' Union, removed from the field of biology one of the most remarkable persons in my acquaintance. He was endowed with many faculties seldom combined in one man. Great physical strength, a fine mind, consuming intellectual curiosity, tremendous drive and keen competitive instinct united to make him an unusual biologist.

His interest in natural history dated from childhood. At the age of 14, he contributed two articles to Lone Scout Magazine, "The Chimney Swift" and "Should Cats be Licensed?" His first Christmas Bird Count, made at the age of 19, was published in Bird-Lore in 1925. He continued to participate in the Christmas Bird Counts with the greatest enthusiasm up to the time of his death.

Hicks was primarily a field biologist, rather than an office or laboratory worker and his greatest contributions were made in this area. He published numerous papers, largely on Ohio birds. As an indication of his productiveness, he had a bibliography of more than 90 titles at the age of 40. A selected list of these is appended.

Lawrence Emerson Hicks was born October 22, 1905, and reared at Fredericktown, Ohio, the son of Earl H. and Floy Coe Hicks, both of whom survive him. He received his undergraduate training at Otterbein College and his M.Sc. and Ph.D. degrees from Ohio State University. He served as game ecologist for the Ohio Division of Conservation from 1929 to 1931 and as wildlife conservationist with the U. S. Soil Conservation Service at Zanesville, Ohio, from 1934 to 1936. In 1936 he became the first head of the Cooperative Wildlife Research Station at Ohio State University, where he served until 1945.

He became an Associate Member of the American Ornithologists' Union in 1929, was elected a Fellow in 1941 and served as secretary from 1937 until 1945. In 1938 he was United States delegate to the International Ornithological Congress at Rouen, where he presented a paper on the European Starling in America.

He was secretary of the Wilson Ornithological Society, 1931-1936 and president, 1940-1941. He was elected to the Wheaton Club of Columbus in 1926 and was president of the organization in 1933-1934, at the age of 28, the youngest man to be elevated to that position in the club's history.

While a student in college, Hicks was employed for two summers on a barberry eradication project in Ashtabula County, Ohio. The

workers covered the area methodically and thoroughly; this survey gave him an exceptional opportunity to study the plant life and the nesting bird populations of this northeastern-most Ohio county. The plant life of the county was the subject of his doctoral dissertation and the nesting birds the basis for the paper listed below. His knowledge of the northern relict habitats of this area was unexcelled.

I made a memorable field trip to Ashtabula County with him in August of 1935, when he aided me in securing for the Ohio State Museum specimens of *Scudderia fasciata* Beutenmuller, a rare species of katydid. The insects were well up in some hemlock trees, too high to reach with an insect net, whereupon Lawrence cut down a large elm sapling with his jack-knife. The sapling was so large that only a strong man could have wielded it, but with it he thrashed the hemlocks, driving out the insects, until we secured a series of specimens, probably larger than the collections of all other museums combined.

Further evidence of Hicks' energy is supplied by his activity in banding Starlings (*Sturnus vulgaris*). In 1927-1929, the Wheaton Club in a cooperative project banded some 7000 Starlings which were captured in cupolas of barns and towers of buildings in the Columbus area. The project was continued by Hicks, usually with two assistants, and by 1937 they had captured nearly 50,000 birds, a remarkable record.

He was greatly interested in athletics. He played guard on the Otterbein football team, although at that time one of the lightest men on the squad. He later became a skilled wrestler and served as coach during the war years for the Ohio State University wrestling squad.

In 1931 he was married to Thyra Jane Bevier. There are two children, Mrs. Clement A. F. Hastie and Thomas Edward Deam Hicks.

In his later years, Hicks operated a large apiaries business. With colonies of bees scattered widely over the state, he had an opportunity to continue his field work on a considerable scale. In recent years, he made many botanical excursions with Floyd Bartley, of Circleville, into southern Ohio. His keen ecological sense and Bartley's botanical discrimination resulted in the finding of many plants not previously reported for Ohio. In these years he also built up a large collection of Indian artifacts.

He had a large ornithological library, a considerable herbarium and a sizeable collection of bird skins. He contributed thousands of sheets of pressed plants to the herbarium of Ohio State University. His collection of bird skins was bequeathed to the Ohio State Museum, and, together with earlier gifts, amounts to well over 2000 specimens. Particularly valuable are numerous birds representing nesting records for Ashtabula County.

In December of 1956, it was apparent to his friends that his health had failed. This fact, however, did not prevent him from entering into the Christmas Bird Counts with his usual enthusiasm. In a period of 10 days, he participated in 6 counts, including one in Ashtabula County, a 3-day round trip from Columbus. At Ashtabula, he shot a White-winged Scoter, then swam out into the icy water and retrieved the bird.

A few days after the last bird count, he collapsed and was confined to his bed until his death.

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## THE FUNCTION OF THE SALT GLAND IN THE BROWN PELICAN

BY KNUT SCHMIDT-NIELSEN AND RAGNAR FANGE

It has long been a matter of speculation how oceanic birds cover their needs for water. Some marine birds remain at sea for weeks or months, hundreds of miles from land and any possible sources of fresh water. Sea water is known to be toxic to man and most other mammals, the reason being its high salt content. Some authors have stated that marine birds do drink sea water (Murphy, 1936: 337), while others have maintained that they can subsist wholly on water obtained from the food (Smith, 1953: 163).

In order to profit from the ingestion of sea water it is necessary for an animal to excrete salts in a concentration at least as high as that in the water ingested. The elimination of the salt would otherwise require an additional amount of water which would be taken from the body tissues. Therefore, if the organism cannot excrete a highly concentrated salt solution, the drinking of sea water only will lead to a progressive dehydration or a harmful accumulation of salt.

The bird kidney is able to excrete salts in a concentration only about one-half of that found in sea water. Hence, if the bird kidney should excrete the salts from a given amount of sea water, it would be necessary to produce twice as much urine as the amount of water ingested. Thus, the kidney is not able to keep a marine bird in a favorable water balance if it drinks sea water.

However, it was recently discovered that in marine birds a major part of the ingested salt is excreted extrarenally. The nasal glands, or salt glands, are able to produce a highly concentrated salt solution, making it possible to tolerate drinking of sea water (Schmidt-Nielsen *et al.*, 1957, 1958). Cormorants as well as a number of other marine birds have been found to secrete salt in high concentrations from the salt gland, and there is little doubt that this is the general avenue for salt excretion in all marine birds. This function is well correlated with the size of the salt gland, which is large in marine birds, as contrasted with terrestrial birds, which have a very small nasal gland. Our findings on the function of the salt gland in the Brown Pelican are here reported.

### MATERIALS AND METHODS

The experimental animals were common Brown Pelicans (*Pelecanus occidentalis carolinensis*). They were caught on the Gulf Coast of Florida immediately before being brought to the laboratory for the physiological studies. Altogether eight birds were used, four with

mature plumage (average weight 3.36 kg.), and four with juvenal plumage (average weight 2.59 kg.). Most of the birds were unwilling to eat in captivity, and force feeding resulted in vomiting. The experimental work was therefore done on fasting animals.

The purpose of the investigation was to establish whether the salt gland plays the same role in salt excretion in the pelican as it does in other marine birds. Stimulation of the gland was accomplished in two different ways, either by imposing a heavy salt load by infusion of hypertonic sodium chloride solution, or by injection of a solution of mecholyl, a synthetic drug with an effect similar to that of parasympathetic nerve stimulation. Although these stimuli do not correspond precisely to the normal situation the bird meets in nature, the salt load is an exaggerated representation of the physiological effects of ingestion of sea water, and the mecholyl injection simulates the action of the secretory nerves that normally control the gland.

All injections were made intravenously in the foot of unanesthetized birds. We have found in other species of marine birds that anesthesia blocks the normal response of the gland to a salt load. Samples of the secretion from the salt gland were collected by means of thin polyethylene tubings introduced one or two mm into the narrow external nares. Occasional samples were taken of urine and of lacrymal fluid for comparative purposes.

The sodium and potassium content of the samples was determined by means of a flame photometer, and chloride by a modification of the Volhard titration method (Rehberg, 1926).

#### RESPONSE TO A SALT LOAD

A salt load was imposed by injection of various amounts of a 10% sodium chloride solution in four pelicans (2 adult and 2 juveniles). Within 1 to 5 minutes after the injection, drops of a clear, water-like liquid appeared at the external nares. The liquid ran down along the grooves on the upper side of the beak until it reached the tip of the beak, where it dripped off. The head shaking which was characteristic in the behavior of cormorants during secretion from the salt gland (Schmidt-Nielsen, *et al.*, 1958) was not observed in pelicans. The secretion continued for some one to two hours.

In a typical salt load experiment with a pelican (2.54 kg. body weight) 28 ml of a 10% NaCl solution were injected intravenously. Within one minute of the beginning of injection the nasal secretion had started. During an initial period of 7 minutes the rate of secretion increased rapidly. When it had reached a high level it continued at a rather constant rate for 110 minutes and then declined abruptly and

ceased altogether during the next 15 minutes. Except for the terminal observation period the flow remained between 0.26 and 0.31 ml/minute (see table 1).

TABLE 1  
VOLUME AND COMPOSITION OF NASAL SECRETION IN A PELICAN  
SUBJECTED TO SALT LOAD

Time, min.	Min.	Vol. of secr. ml.	ml per min.	Conc. mEq/liter		
				Na	Cl	K
0-7	7	—	—	650	—	11
7-17	10	2.885	0.29	637	656	10
17-27	10	2.686	0.27	700	695	12
27-37	10	2.997	0.30	764	850	15
37-57	20	6.155	0.31	736	740	16
57-77	20	5.879	0.29	721	730	14
77-97	20	5.209	0.26	704	708	14
97-117	20	5.119	0.26	696	704	13
117-132	15	2.815	0.19	676	694	14
Total: 33.745 Aver.: 0.27				698	722	13

The total amount of liquid secreted from the salt gland in this experiment was 33.75 ml. In the same period four samples with a total volume of about 22 ml of cloacal contents were passed (most of this was only slightly contaminated with fecal material). The amount of liquid produced by the salt gland therefore exceeded the amount produced by the kidney. However, the important difference in the roles of these two organs appears when the salt concentrations are compared.

While the average salt concentration in the nasal secretion was over 700 mEq/liter (ab. 4 g NaCl per 100 ml), the average urine concentrations were about 250 mEq/liter (ab. 1.5 g NaCl per 100 ml) (see table 2). With the smaller volume of urine and its much lower salt concen-

TABLE 2  
VOLUME AND COMPOSITION OF URINE SAMPLES DISCHARGED DURING  
THE EXPERIMENT DESCRIBED IN TABLE 1

Urine vol. ml	Conc. mEq/l		
	Na	Cl	K
6.7	222	251	18
7.1	207	205	7
5.9	261	316	38
1.9	156	269	52
21.6	212	260	29

trations, it appears that the amount of salt eliminated by the kidney is about one fifth of the total, while about four-fifths of the salt was excreted from the salt gland in the observation period of slightly more than two hours (see table 3).

In this connection it is desirable to emphasize that the salt load imposed in this experiment was in the form of a salt solution about three times as concentrated as sea water. Such loads would not occur in nature. The total volume of nasal secretion (33.75 ml) exceeded the injected volume of salt solution (28 ml). Its concentration of salt (ab. 700 mN), although not as high as in the injected solution (1710 mN) was well above that of sea water (ab. 550 mN). In other words, the salt gland has the capacity to excrete the salts contained in ingested sea water.

TABLE 3

THE AMOUNTS OF SALT EXCRETED IN A PELICAN DURING TWO HOURS AFTER THE INJECTION OF A SALT LOAD OF 28 ML OF 10% NaCl SOLUTION

	NaCl injected	Nasal excretion	Renal excretion	Total excretion
Volume, ml	28	34	22	56
Total NaCl, mEq	47.9	23.9	5.3	29.2
Total NaCl, gram	2.8	1.4	0.3	1.7

#### RESPONSE TO OTHER STIMULATION

Previous work on cormorants has shown that the secretion from the salt gland is stimulated not only by a load with sodium chloride, but also by a general osmotic load in the absence of increased salt concentrations (Schmidt-Nielsen *et al.*, 1958). This was shown by the injection of hypertonic solutions of sucrose, which stimulated a secretion similar to that observed after a salt load.

Studies on gulls, which will be described in another publication, have shown that the innervation of the salt gland is of parasympathetic nature, and that secretion from the gland can be stimulated by mecholyl (methacholine chloride), a drug that mimics parasympathetic stimulation and causes secretion from a number of glands. It was therefore of interest to compare the stimulation by mecholyl in the pelican with its effect on gulls. Mecholyl was injected intravenously in amounts of from 0.1 mg to 0.17 mg per kg body weight. Secretion from the salt glands as well as secretion of tear fluid started immediately and continued for periods up to ten minutes. The rate of secretion from the salt glands was rather low, the highest rate observed under mecholyl

stimulation was 0.17 ml/minute for a five minute period. Hence, some samples obtained were too small for complete analysis, but sodium determinations could be made on five samples. These ranged from 590 to 750 mEq Na/liter (aver. 652 mEq/l). In other words, the concentration was similar to that obtained by a salt load (see table 1). Potassium was from 10–18 mEq/l, and chloride from 632 to 708 mEq/l.

The mecholyl stimulation also provided an opportunity to obtain samples of lacrymal fluid. In the three samples obtained the sodium concentrations were 52, 83 and 93 mEq/liter, respectively. This is lower than the sodium concentration of the plasma, which is about 150 to 160 mEq/liter, and it clearly shows that the glands that produce the lacrymal fluid have no role similar to that of the salt gland in the excretion of salt.

#### THE MAJOR GLANDS IN THE ORBITAL REGION

In the Brown Pelican the salt gland, or nasal gland, is located in the upper anterior portion of the orbital cavity of the skull close to the interorbital septum (see figure 1). A shallow depression in the underside of the bony roof of the orbit (*praefrontale*) marks the place of the gland. The position of the gland is the same as reported by Technau (1936, p. 560) in *Pelecanus onocrotalus*. The gland has an oblongate pear-shaped form with a length of 2.6–3 cm and a width of 0.6–0.8 cm. The surface of the gland is slightly lobulated. The attenuating anterior end continues forward horizontally as a duct that is about 1 cm long

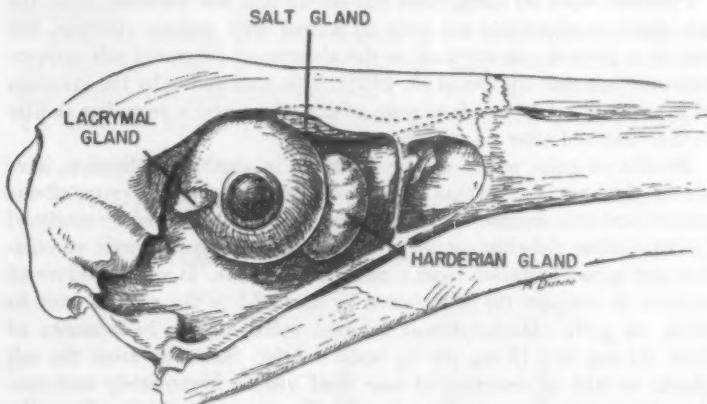


FIGURE 1. Orbital region of Brown Pelican, showing location of major glands.

and opens into a narrow cavity a few mm behind the external nares. A gland taken from a bird which has just been secreting has a reddish color, probably due to the rich blood supply. According to one single observation a non-secreting gland is paler and of a somewhat smaller size than a secreting gland. The microscopical structure is very similar to that of the salt gland of gulls (manuscript in preparation). The secretory elements consist of parallel closely packed glandular tubules radiating from central ducts. The gland tissue is surrounded by a thin connective tissue membrane. Several blood vessels and thin nerves pass into the gland but the anatomy of these was not studied.

The weights of the major glands of the orbit were determined in six pelicans. The results of these weighings are tabulated in table 4.

TABLE 4  
WEIGHTS IN MG OF THE MAJOR GLANDS IN THE ORBITAL REGION  
OF THE BROWN PELICAN

Animal No.	Body wt. kg	Salt gland			Harderian gland				
		L	R	Total	mg/kg BW	L	R	Total	mg/kg BW
A (ad.)	3.74	520	474	994	266	1776	1805	3581	958
C (ad.)	3.17	483	480	963	304	2065	2053	4118	1290
D (ad.)	3.41	—	536	— est. 314	314	2491	2487	4978	1462
E (juv.)	2.86	382	384	766	258	1894	1935	3829	1339
F (juv.)	2.36	370	353	723	306	2082	2052	4134	1753
G (juv.)	2.54	540	530	1070	421	2194	2126	4310	1697

The most striking finding is that although the salt gland (nasal gland) is quite large, the Harderian gland is some four to five times as large again. This gland forms a white or yellowish rounded mass in front of the eye bulb. Its histological structure is vesicular and different from the salt gland. The lacrymal gland is situated behind the eye. It is a small gland which in three cases weighed from 8 to 12 mg.

The normal function of the large Harderian gland is not known with certainty. However, it is likely that the "tears" that appeared under mecholyl stimulation (see above) came from the Harderian gland. The amount of "lacrymal" fluid that was obtained in about a minute ran as high as 342 mg, and it is unthinkable that this amount of fluid was secreted by the lacrymal gland which weighs only some 10 mg. These "tears" could, on the other hand, easily be produced by a gland as large as the Harderian gland. As described earlier, the fluid is hypotonic, and it is viscous and slow flowing. It could well serve for protection of the eye of a diving bird, where the high viscosity would be a help in keeping it from being washed away.

In contrast, the secretion from the salt (nasal) gland is always high in salt concentration and water-like in consistency. With the rates of secretion observed, which ranged up to 0.38 ml/minute (Pelican C) it can be estimated that the salt glands can secrete a volume of liquid about four tenths of their weight per minute. This is indeed a very high rate of secretion, particularly in view of the considerable osmotic work involved in the secretion.

#### DISCUSSION

While sea water is known to be toxic to most mammals and terrestrial birds, it has been debated whether marine birds drink sea water. For an animal to tolerate drinking of sea water it is necessary to excrete the salts in a concentration at least as high as in the water taken in. While the bird kidney cannot produce a urine as concentrated as sea water, the excretory function of the salt gland (nasal gland) is very efficient, producing a fluid with salt concentrations higher than that in ingested sea water, thereby leaving a net gain of water.

It is well known that the nasal gland is particularly well-developed in marine birds. The significance of this has been discussed, and the commonly accepted conclusion has been that the large nasal gland produces a secretion which will rinse away the harmful or irritating effect of sea water that penetrates into the nasal cavity (Marples, 1932). Of 83 species of birds examined by Technau (1936) the 24 species that had particularly large glands were all marine. It is interesting to note that Technau's careful investigations also revealed a correlation with the habitat of the bird within a single genus. For example, among gulls the size of the gland increases as we move from the European Black-headed Gull (*Larus ridibundus*), through the Mew Gull (*Larus canus*) and the Herring Gull (*Larus argentatus*) to the Great Black-backed Gull (*Larus marinus*). In Europe the Black-headed Gull is mostly a fresh water species; it breeds at fresh water and spends much of the year on the big European rivers. The Great Black-backed Gull, on the other hand, has the most pronounced marine habitat of all the species mentioned. The same trend to a correlation with the extremeness of the marine habitat is evident in other birds listed in Technau's well compiled tables.

It has, furthermore, been shown that the size of the salt gland to some extent depends on the adaptation of the bird to its habitat. For example, Schildmacher (1932), working in the Berlin Zoo, found that when ducks of the same species were brought up in salt water and in fresh water, those brought up in salt water had considerably larger nasal glands.

While these correlations between the size of the salt gland and the marine environment are well established, it is necessary to modify the interpretation that the function of the gland is to protect the nasal membranes against sea water. Instead, it is evident that the gland has the unique role of being the main organ for excretion of salt in marine birds.

#### ACKNOWLEDGMENTS

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#### SUMMARY

The salt gland (nasal gland) of the Brown Pelican can excrete a highly concentrated solution of sodium chloride. The excretory capacity of the salt gland permits the bird to tolerate ingestion of sea water, and to profit from it because the salt is excreted in a concentration higher than in sea water. Quantitatively, the role of the salt gland in the elimination of sodium chloride is greater than that of the kidney.

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## COURTSHIP, HOSTILE BEHAVIOR, NEST- ESTABLISHMENT AND EGG LAYING IN THE EARED GREBE (*PODICEPS CASPICUS*)

BY NANCY M. MC ALLISTER

THE behavior of North American grebes is little known. This is especially true of their nesting behavior. They are relatively secretive and nest in marshes out of reach of most observers. This paper describes courtship, hostile behavior, nest establishment, nest building, copulation, and egg laying of the Eared Grebe, and discusses some of the comparative aspects of these behavior patterns. In addition, some problems of clutch size and laying interval are considered.

Simmons' work (1955) on the Great Crested Grebe of Europe, *Podiceps cristatus*, has been used extensively for comparison with the Eared Grebe.

### THE STUDY AREA

The study area was near Williams Lake in the Cariboo district of British Columbia, 52.00° North latitude, 122.00° West longitude, and 1500 to 3000 feet above sea level. The Cariboo Parklands biotic area or biome as described by Munro and Cowan (1947) is flat to rolling grassland broken by stands of lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), and aspen (*Populus tremuloides*). Frequently the bottoms of depressions in the grassland hold shallow lakes varying in size from a few acres to twenty square miles. The Eared Grebes chose lakes about a mile by half a mile.

The study lakes, Westwick and Sorensen, were once one but are now artificially divided by an unpaved road. The lakes are carefully described by Munro (1941). The greatest depth is twelve feet, but more than half the lake area is less than five feet deep. These highly productive lakes have at least a foot of thick black mud on the bottom. The clear water is filled with numerous small invertebrates, but no fish. The concentration of invertebrates is such that food does not appear to limit the populations of any of the birds using the lakes. By the middle of July, the bottom flora reaches to within two feet of the surface and extends over ninety percent of the bottom area. In addition dense mats of floating algae cover one fourth of the surface by the end of July. The bottom plants are *Scirpus*, *Ruppia*, *Ceratophyllum*, *Myriophyllum*, and *Potamogeton*, and the floating forms are principally *Aphanizomenon* and *Cladophora*.

Westwick Lake had a colony of two hundred and ten pairs of Eared Grebes, and Sorensen Lake a colony of forty pairs. This study was

made during the summers of 1955 and 1956, using ordinary observational methods. Sex of the birds could often, but not always, be told. The males had larger crests and sometimes appeared to be larger in total body size. Diagrammatic drawings of some of the patterns described are shown in figures, and the courtship patterns of the Eared Grebe and the Great Crested Grebe are compared in Table 1.

Dr. I. McT. Cowan deserves my greatest thanks for his valuable suggestions and enthusiastic support. I also wish to thank all the others who helped with the manuscript. Financial support came from the National Research Council of Canada.

#### COURTSHIP DISPLAYS

Courtship display was seen as soon as the Eared Grebes arrived at the breeding lakes. In 1955 the first grebes arrived on May 1; in 1956 a few were on the lakes when I arrived on May 2. In both years most of the grebes had arrived by the end of the first week of May.

Courtship was mutual; all patterns noted were performed by either sex. The courtship displays were all done on open water in the center of the breeding lakes. There was no territory of any kind involved, and each bird made use of the whole lake area. The Great Crested Grebe (Simmons, 1955) courted on territory and used the defense of territory boundaries as part of its courtship.

Courtship display tapered off abruptly as nesting behavior began. The colony, stimulated by courtship, acted as a unit in the total change in behavior. Simmons (1955) described a similar abrupt change of behavior in the territorial Great Crested Grebe, but each pair had its own change-over time. The increased use of advertising behavior seemed to serve to synchronize courtship in the Eared Grebe and create a true colonial situation.

#### Advertising Behavior

Advertising behavior was seen where an unpaired bird was in search of a mate, or when a paired bird had temporarily lost touch with its mate. The advertising bird swam up and down approaching other grebes with a characteristic attitude (fig. 1) and call. The feathers of the whole body were fluffed out making the posturing bird seem larger than its fellows. Both crest and neck feathers were raised, the neck was erect, and the bill was directed straight forward and closed during the call.

The call was a three-noted *poo-eee-chk*, but the ending *chk* could only be heard at very close range. It may be produced, as Simmons (1955) suggested for the Great Crested Grebe, by the effort of producing the first two notes. The first two notes were plaintive and slurred, about

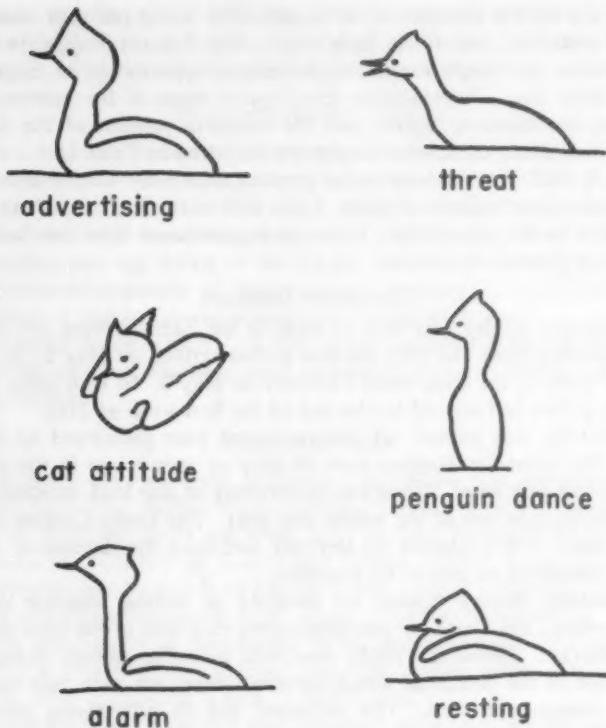


FIGURE 1. Some behavior patterns of the Eared Grebe.

a musical fifth apart. They sounded much as if played on a flute. The third note was on the same pitch as the first but much quieter and very gutteral.

Eared Grebes gave the appearance of being paired on arrival in the spring. More than half were swimming in pairs on the day of their arrival at Westwick Lake. When a single bird approached a pair, situations such as the following occurred: "One of the pair swam toward the advertising intruder, and it turned away and left them." "Intruder appeared and swam between the paired birds and around them. The male of the pair ignored the intruder for a while and then rushed at him from a distance of four feet in a threat attitude. Then the pair moved off while the intruder moved into the reeds." Such incidents as these led Munro (1941) to say that the birds were paired

on their arrival, and my judgment originally followed his. Closer study of individual pairs, however, showed that none of the Eared Grebes were paired definitively at this stage. Partnerships lasted from three hours to five minutes. An advertising single bird of either sex swam up to the pair and took one of the pair away. The other of the pair then went off and advertised. The number of changes of partners seen dropped off rapidly until pairs were definitive a few days before nesting behavior was first seen.

The advertising position of the Great Crested Grebe described by Simmons (1955) seems the same as that of the Eared except that the crest of the larger species is depressed. The elements of the Great Crested Grebe advertising call seem to be the same as those of the Eared Grebe call. The Great Crested Grebe remained stationary while advertising, which may be related to the territorial nature of its courtship. The Eared Grebe might be either stationary or swimming. It might even swim up to other grebes, but it was not seen to be aggressive.

#### *Habit Preening*

Courting grebes floated along in pairs and preened vigorously. This behavior did not differ in aspect from ordinary comfort preening and I saw nothing to indicate that it was a courtship activity. However, between these bouts of comfort preening, a different kind of preening was seen. The two birds drifted within a foot of each other and preened together; either bird might lead, but the other repeated the movements exactly. The timing was so close that it was often difficult to tell which bird was leading. There was no definite sequence of movements, but both birds preened the same feathers at the same time. The movements were a little quicker and not quite so thorough as those of comfort preening. The participants were most frequently side by side but might end up facing each other. I have not seen this pattern except during the courtship period, and I think it must have a courtship function.

Habit preening is by far the most common courtship pattern in the Eared Grebe. It is also reported for the Great Crested Grebe (Simmons, 1955), but in that species head shaking was the more common courtship movement.

#### *Head Shaking*

Head shaking was seen both as a separate ceremony and as part of the penguin dance. As a separate ceremony the two birds swam along rapidly, one in front and slightly to the side of the other. Their body feathers were raised, and their position was very high on the water. Their necks were stretched up higher than in the advertising behavior

with crest raised and neck feathers depressed. The general effect was taller, higher on the water, and thinner than in the advertising attitude. The head was turned smartly left and right, all in the horizontal plane. The tempo was military, precise but not hurried. Six to twelve turns constituted a ceremony; then both birds usually dove. The timing of both the turns and dive was generally quite precise as the following bird apparently copied the leader. Either sex might lead, and once head shaking was seen done by an unpaired bird. After advertising to a pair, the odd bird did several head shakes, and the female of the pair swam off with him.

The head shaking ceremony was as common as the cat attitude (fig. 1), but not as common as the penguin dance (fig. 1). In about half the instances recorded, head shaking was directed toward other grebes, paired or single birds, as a threat. Once the shaking pair were riding so high on the water that white breast feathers were visible.

In the Great Crested Grebe (Simmons, 1955) head shaking almost replaced habit preening and the penguin dance. In addition to courtship, it is used to cement the pair bond during and after territory-boundary disputes. The use of shaking as threat toward an intruder was the only Eared Grebe counterpart of this. The attitude of the Great Crested Grebe was basically the same as that of the Eared Grebe, but the birds usually faced each other and were always stationary. Often, too, their bills were below horizontal. Faster turns were alternated irregularly with slower ones in the Great Crest, while the tempo was even in the Eared Grebe. The Great Crested Grebe had a special head-shaking call.

Huxley (1914) described Great Crested Grebes head shaking while back to back, but Simmons (1955) had never seen this variation. Wetmore (1920) cited the same for the Eared Grebe, but I have not seen it. Kilham (1954) described a pair of Pied-billed Grebes (*Podilymbus podiceps*) head shaking while they swam near each other.

#### Penguin Dance

The penguin dance is that peculiar display in which grebes stand up like penguins while treading water. The penguin dance (fig. 1) was more common than the cat attitude or head shaking, but less common than advertising behavior and courtship preening. Both birds would tread water face to face raising their white breast feathers out of the water and seemingly stood on their tails. Their bellies were only a few inches apart, and they paddled their feet alternately and so rapidly that they sometimes splashed. As they stood up they uttered a shrill chittering call and shook their heads violently from side to side. There were from six to twenty head shakes, but the pace was so fast that the birds were usually out of phase. Dropping to the water, they slowed

head movements to the pace of the head shaking ceremony, and eight to twenty turns were made from the swimming position facing each other. Only once were Eared Grebes seen shaking face to face without first going through the dance. Sometimes the birds turned during this last head shaking and continued as in a normal shaking ceremony, swimming together down the lake. Sometimes they simply stopped head shaking, drifted apart, and comfort preened. Habit preening was a part of the post-dance ceremony about a third of the time. The beak was dipped eight to sixteen times to the breast feathers or primaries either before or during the head turns. The preening movements were here even more ritualized than was seen in the usual head shaking. The feathers were touched but not stroked, and the rhythm of the ceremony was not broken.

Very occasionally the Eared Grebes turned while still standing and ran a short distance on the water before settling down to head shake. Usually the birds stood up actually facing each other, but occasionally they stood up facing the same direction, but turned while standing to face each other. This turning seemed to be the same as that seen in the Great Crested Grebe discovery ceremony (Simmons, 1955). In diving the Great Crested Grebe most often overshot its mate, came up facing away from it, and turned to face it. The mate was in a cat attitude, and the diving bird slowly dropped to the water, head shaking with it. I have not considered the discovery ceremony under a separate heading, because I think that it is an incomplete form of the penguin dance. This incomplete form is the more common form for the Great Crested Grebe, and the complete form was rarely seen. When it did occur, Great Crested Grebes dove and each of the pair brought to the surface a bit of pond weed, swam toward its mate and rose in the penguin dance. The Eared Grebe may begin its dance from a dive or from the surface; but the use of weed was not seen.

The Great Crested Grebes leaned against each other during the penguin dance (Simmons, 1955), but the Eared Grebes stood without leaning.

The chittering call of the Eared Grebe penguin dance consisted of the two notes of the advertising call uttered more quickly and in wild excitement. In construction it is the same as the threat call, but the quality seemed more musical. Simmons (1955) did not describe any call for the penguin dance of the Great Crested Grebe. Perhaps, since head shaking was so closely related to the dance, the head shaking call was used. The Eared Grebe was not heard to call during head shaking.

Occasionally in the Eared Grebe an unmated bird flapped in high intensity threat at a pair doing the penguin dance. Often it came from

quite a distance at the sound of the dance. This was more likely to happen later in the season when the odd bird had been advertising for a long time.

In the Eared Grebe I did not observe the penguin dance after a pair had begun nest building. Lawrence (1950) said that the upright rush of the Western Grebe (*Aechmophorus occidentalis*) was seen in reduced intensity all summer; but the upright rush may not be homologous to the penguin dance of other grebes.

#### Cat Attitude

In the cat attitude the head was drawn down on the breast with the crest and neck feathers raised (fig. 1). The raised body feathers made the birds look much larger than usual, and the wings were away from the body but bent. The carpal joint was tipped forward and down to almost touch the water. The posturing bird exactly faced the bird eliciting the display, thus making more striking the orange circle of plumes in the center of the larger black circle of the wings and body. The attitude of the Great Crested Grebe seems to be the same.

The cat attitude was quite rare compared to the other courtship patterns. Apparently the Great Crested Grebe (Simmons, 1955) uses it more than the Eared Grebe. Its function is not clear. Both grebes used the cat attitude when an unmated bird had been advertising. Another grebe swam toward the advertising bird and dove. The advertising grebe assumed the cat attitude, and the approaching bird rose in the penguin attitude. Paired Eared Grebes used the same ceremony without previous advertising. In the Eared Grebe the penguin dance seemed always to follow; in the Great Crested Grebe head shaking followed. Once a female Eared Grebe assumed the cat attitude facing an advertising male as he passed. Her mate immediately drove the odd bird away. Rarely in either species one bird flapped over the water a little way and did a cat attitude turning to face its mate. Or it might just patter away and swim back without using the cat attitude. The penguin dance or head shaking followed respectively as seen before. In addition the Great Crested Grebe unmated female used the attitude when threatened by a mated male. I have included this section under courtship and made no mention of it under threat as Simmons (1955) did, because I think that it is not related to threat behavior.

#### HOSTILE BEHAVIOR

##### Threat Attitudes

Threat behavior was seen under two sets of circumstances. During the courtship period, advertising birds (fig. 1) swam up to courting

TABLE I  
COURTSHIP PATTERNS COMPARED

	<i>Eared Grebe</i>	<i>Great Crested Grebe</i>
Advertising Behavior:		
neck erect, bill forward	x	x
crest and neck feathers raised	x	
crest down		x
body feathers fluffed	x	x
body high on water	x	x
call: <i>poo-eee-chk</i>	x	
<i>grr-owp row-ah</i>		x
done while: moving	x	
stationary		x
done by lone bird mated or not	x	x
Habit Preening:		
precise, stereotyped movements	x	x
primaries and breast used mostly	x	x
preens whole body	x	?
seen alone or with head shaking	x	x
Head Shaking:		
neck erect, medium stretched	x	x
crest up	x	x
neck feathers down, body feathers medium	x	x
bill: forward	x	
slightly down		x
facing: forward	x	
each other		x
done swimming	x	
done stationary		x
done between battles		x
used by pair as threat or courtship	x	x
Penguin Dance:		
head turning	x	x
crest up, bill forward	x	x
neck medium stretched	x	x
body and neck fluffed	x	x
standing position	x	x
leaning		x
not leaning	x	
chitter call	x	?
elicited: by diving for weed		x
by penguin	x	
from surface	x	
by cat attitude	x	
turn forward while shaking	x	
stay facing each other	x	x
followed by head shaking	x	x

## Cat Attitude:

head withdrawn, crest raised	x	x
body feathers raised	x	x
wings out, tipped forward	x	x
faced partner	x	x
elicited by penguin	x	x
elicited by mate approaching on surface	x	
female may do it when threatened		x
followed by: penguin dance	x	
head shaking		x

pairs and were either driven off or accepted by one of the courting birds while the other swam away. Later, during nest establishment, the birds owning and defending nest platforms threatened and drove away any Eared Grebes approaching within about two feet of the platforms. Throughout the nesting season nests were defended in this way. But during courtship and on open water during nesting, threat was rare. While there is complete overlap from the highest to the lowest intensities of threat, three arbitrary divisions can be made on the basis of the elements included. The higher intensities were more characteristic of nest defence, and the lower of courtship.

At low intensity the angle of the neck was forty-five degrees forward, the bill straight forward and open (fig. 1). The feathers of the neck were laid down and those of the crest raised. The threatened bird usually just swam away. At middle intensity the birds swam slowly toward the threatened bird in the low intensity threat attitude. In high intensity threat the low intensity threat attitude was taken first. Then the wings were raised and the bird flapped over the water toward the other bird. The threatened bird escaped by diving, was sometimes followed a short distance, and might be struck or bitten before it had a chance to get away by diving. The striking motion involved drawing the head back and then thrusting it forward. The movement seemed to be the same as that performed in diving, and the dive was sometimes actually completed at the end of the rush. The threatened bird turned away as the rush began and took the blow, or most frequently the bite, on the side or wing. Threat seemed always to be successful in driving the intruder off. The Eared Grebe had moving attack-escape sequences instead of the stationary fighting and upright threat of the Great Crested Grebe (Simmons, 1955).

The threat call was almost always associated with the middle and high intensity threat, rarely with the low. The call is a loud chitter, the two notes about a musical fifth apart and alternated rapidly. In spite of the speed, each syllable is individually accented.

The forward threat and attack of the Eared Grebe appear to be the same as those used by the Great Crested Grebe (Simmons, 1955), and the Great Crested's bark call seems to be homologous with the chitter of the Eared. It is interesting that Simmons reported in the Great Crested Grebe so many variations of the threat call. This may be associated with its apparently greater use of threat behavior. I have observed no upright threat posture in the Eared Grebe, perhaps because two Eared Grebes never seem evenly matched. The Eared Grebe had no large territory boundary, for the only territory defended was the nest itself, and there one pair was always dominant.

In the fighting of the Great Crested Grebe, Simmons said, "both grebes leap at each other and clash vertically breast to breast." It is not clear whether this was the upright swimming posture of the upright threat or the standing posture of the penguin dance (fig. 1). This standing position, I have never seen in the Eared Grebe. Dubois (1918) described the Horned Grebe, *Podiceps auritus*, as having a lunging attack similar to what I saw in the Eared Grebe. Wetmore (1920) spoke of a female Pied-billed Grebe, *Podilymbus podiceps*, with young as "rising threateningly on the water, made a great boiling noise by treading rapidly with her feet." As the presence or absence of the standing fighting or threat behavior may have importance in tracing the evolution of some of the courtship patterns, it should be more thoroughly investigated.

During the courtship period a pair of Eared Grebes may use the head shaking courtship pattern as threat.

#### *Escape Attitudes*

The alarm posture (fig. 1) was seen during courtship when the birds were disturbed by man. No other animal or natural phenomenon was seen to produce it. During nesting the alarm attitude was the usual one for birds on open water. They were shy and constantly alert during this time. When the eggs were hatched, the grebes returned to the former resting posture.

In the alarm attitude the feathers of the body, neck, and crest were all laid down. The neck was extended vertically, and the bill was straight forward. The wings were tightly closed. The grebe was ready to escape by diving, submarine diving, or flapping across the water. The alarm attitude is probably part of the intention movements of escape. The posture seems to be the same as that of the Great Crested Grebe (Simmons, 1955) but I do not find it described for any other species.

I have heard no call in alarm or escape behavior. This is particularly

noticeable in the nesting colony, where, even with the most silent approach, I seldom saw and never heard a grebe; only the empty nests were found.

Simmons (1955) did not mention whether or not the Great Crested Grebe had an alarm call. Gross (1949) described the Least Grebe, *Podiceps dominicus*, male as having an excited call, *yeep-yeep-yeep*, followed by a rattled *ye-ye-ye-ye-ye-e-e-e-e-e-e-e*. The female and young all dove "in a wild splash at this signal." Deusing (1943) said that the Pied-billed Grebe had a *hu,hu,hu,hu* call continued for several seconds, which he said might be an alarm call.

When a person or boat or other strange object appeared close to a grebe, it first assumed the alarm posture, and then escaped. When another grebe attacked it, however, it escaped without using the alarm posture. Escape may be made by pattering over the surface, by diving, or by the submarine dive. The crash dive was only seen in extreme circumstances, and was a combination of diving and pattering over the water. The wings were raised as if for flight, but the bird dived and used its wings a short distance under water. The submarine dive was almost as common as the ordinary escape dive and pattering. Unlike these, it was never seen except in an alarm situation. In this pattern the grebe sank out of sight from the alarm attitude, body first, then neck, then head.

#### NESTING

##### *Beginning of Nest Establishment*

In the course of one week, the behavior of the grebes changed abruptly. Late arrivals were conspicuous exceptions, keeping apart in a little group until they finished their courtship. When they began nest establishment behavior, these late arrivals were absorbed into the larger group. Before May 16, 1956 none of the elements of nest establishment was seen; after May 20 none of the courtship patterns was seen. The situation was the same and the dates were almost identical in 1955. The change is evident even to the casual observer. In the first period feeding and resting are closely intermingled with courtship; there is almost always a pair courting somewhere in sight. The birds are scattered all over the open water. The number of calls of the advertising courtship pattern makes the lake seem noisy all day, and the birds are very tame when approached.

In contrast, nest establishment behavior is seen each day for short periods only, and the whole colony is usually involved. These mating parties are always in the reeds or floating vegetation, and show platform building, platform defense, soliciting, and copulation. Between

parties the birds spend most of their time resting in large groups near the reed area where they last built nest platforms. They scatter to feed periodically but always return to the group. While on open water they are silent and increasingly shy.

The change from courtship to nest establishment depends on the date the ice goes out and the temperature in the early part of May. The birds almost all arrive in the first three days after the ice breaks up on the breeding lakes. The warmer and sunnier it is in May (it seldom exceeds 85° F.) the greater the degree of courting activity. Presumably a certain amount of courtship must be done before the birds begin to change to nesting behavior. This is suggested by the observation that late flocks continue to court after the early flocks have already started nesting activities.

#### *Soliciting*

Soliciting is the first behavior pattern of nest establishment seen each spring. In a soliciting grebe, the body is low in the water, neck forward, and head and bill laid straight out on the surface of the water. The neck is not unduly extended, and the crest is down. Both sexes may solicit and both call. This position is the same as the position of the female in copulation except that in copulation her bill is usually pointed slightly down. One call is associated with both soliciting and copulation. It is an eerie note somewhat similar in quality to the scream of the Red-shouldered Hawk, *Buteo lineatus*. It does not, however, change in pitch. The soliciting bird may be answered by its mate with the same call. Later in the season both birds solicit on the nest platform and copulation follows.

Simmons (1955) states that the Great Crested Grebe rarely solicits on the water, and does not start soliciting until the platform is at least partly built. The position taken is the same as that of the Eared Grebe, except that the neck is somewhat stretched. Simmons does not mention that any call accompanies this pattern as in the Eared Grebe.

The Great Crested Grebe has another soliciting display in which it stands on the nest and arches its head as though to peer at its feet. Simmons (1955) refers to this as rearing. Hosking (1949) describes a similar pattern in the Horned Grebe, *Podiceps auritus*. Buddle (1939) gives a photograph of the New Zealand Dabchick, *Podiceps rufopectus*, in the rearing attitude. I have not seen this in the Eared Grebe, although it may occur. Perhaps rearing is the ritualized intention movement of sitting down on the nest. Motion pictures of both rearing and sitting down on the nest would be helpful in deciding this question. Rearing also resembles the copulation posture of the male and the posture of both birds in turning the eggs.

*Development of Platform Building*

Nest or platform building begins at a very low intensity a few days after the first soliciting. The birds begin to drift all together into the reeds. Almost any place may be chosen, but some floating algae or reeds must be present. Isolated tufts and sparse floating pondweeds totally unsuitable for finished nests may be used for these early platforms. As the birds swim slowly around in the chosen area, a single female may pull a broken reed over and lay it across another reed caught between two upright stalks. Then the whole group swims away and resumes feeding.

With each occasion of group activity the intensity of the behavior increases and more pairs become involved. On Sorensen Lake the evening of June 9, 1955, this sequence was seen: At sunset the birds were all feeding on open water. A pair drifted into the entrance to the marsh, and the birds swam to opposite sides of a reed tuft in the middle of the channel. This tuft was one of a group of three each containing less than a dozen reed stalks. The female pulled at a long floating reed and added some floating algae to that already caught in the reed tuft. Several pairs swam by and were driven off, the area defended being only a foot or two around the platform. This pair held the tuft until dark at eleven P.M. and copulated on it about a dozen times. Several other pairs could be heard similarly occupied in the marsh, but the majority of the birds had not yet chosen tufts and trouped up and down in a body, heads down in resting posture. These early platforms are shown in Plate 13.

More and more pairs became involved, until on May 18, 1955 an active party was seen on Westwick Lake. The day was warm and sunny, and the grebes were feeding all over the lake. At four P.M. a disturbance on the far shore caused the grebes to drift toward me. In the next half hour they were all in the reed fringe in front of my canoe. The eerie trilling of the copulation call began and increased as pair after pair joined in. Six pairs solicited and copulated on old nests. Pairs rushed at each other, wings raised and beaks open in threat. A dozen small battles raged at once and the threat calls of fifty individuals were so continuous that I could not distinguish the birds which were calling. Six single birds tried to attract mates but were dealt with violently by both members of each pair they approached. American Coots (*Fulica americana*) and Ruddy Ducks (*Oxyura jamaicensis*) swam by and were not bothered by the grebes.

These parties start spontaneously and may take place in a different area each time. There is a tendency to use one reed bed for several days and then to move to another. The moves took place both on the



Eared Grebe. *Above:* An area of sparse reeds showing five unfinished nests used for copulation. *Below:* An early unfinished nest used for copulation.



Nests of Eared Grebe. *Above:* A nest not yet complete. *Below:* A finished nest with abandoned egg. The egg has been pecked by a grebe.

lake that I was watching from the canoe and on the lake which I watched only from a distant hillside. I doubt, then, that my presence disturbed the birds and caused them to move. The moves may have been connected with the increasing maturity of the nesting patterns.

In each of the two summers the grebes at one time chose an area of reeds far too sparse to support nests. On June 21, 1955 the grebes were in an area of new reeds in the center of Westwick Lake. The tufts each contained less than a dozen stalks and were several feet apart. I could see in this open area the beginnings of nearly fifty nests. The grebes were alternately soliciting on the new platforms and adding new material to them. Five nests had one egg; one nest had two. A thundershower accompanied by strong winds the next night destroyed the nests, and activity switched to a new area.

#### *Nest Building Patterns*

All the building seemed to be done by the female. The male followed the female but was not seen to handle nest material. Since it was difficult to tell the sexes apart, some errors may have been made here. If only the female builds, this is the only pattern besides copulation in which the roles of the sexes are not the same. The female dives near the nest site and comes up about two feet from it with a large beakful of algae, lays it on the edge of the heap with a quick reaching movement, and dives again. The nest is set on a foundation of several bent-over reeds. It may be in the center of a small clump of reeds or at the side of a large clump. The heap of debris finally makes a more or less pyramid-shaped pile reaching from a foot or two from the bottom of the lake to slightly above the surface. Three hours is sufficient time for the construction of a nest. Additional material may be added to the sides of the nest during the egg-laying period.

The center of the nest is cupped, but the rim is never more than an inch above the center. The whole nest is soggy, and the center may be slightly below water level even when the adult is not on it. The lower half of each egg is always wet.

The nest material depends on the lake bottom in the immediate vicinity of the nest. Nests built in a new reed bed were bright green, completely constructed of living algae; those in old reed beds were nearly black with rotting reeds and algae. All the nests had the appearance of being molded of wet clay, smooth and soft.

The colonies were compact units in the densest part of the reed bed and visible neither from the shore nor from open water. The final nests on other lakes, however, are often built much more in the open. Nests are from one foot to three feet apart and are in water one to three and a half feet deep. Places where there are surface algae are

avoided. The first nests in the final colony are in a group and form a nucleus for the development of the colony. Darling (1938) suggested that a central nucleus and concentric rings is the usual colony form in gulls. The colony is compact, using every available reed tuft in the area.

When nest building, the females assume a shy attitude that continues through egg-laying and incubation. Their crests and neck feathers are sleeked down in a low intensity alarm attitude. The males do not seem to adopt the alarm attitude until the middle of egg laying.

Nest material was never seen used ritually in courtship or as an invitation to nest.

#### *Copulation*

Copulation occurs frequently from the time the first platforms are made until the end of egg laying. The female hops up on the platform with a thrust of her legs, wings closed. She stands on it with her legs out like props for a few seconds and then drops down on her belly. She stretches her neck forward and holds her bill pointed down at a forty-five degree angle. Her head and neck feathers are flattened. The male swims around behind the nest and hops up on her back without opening his wings. He stands at an angle slightly forward of vertical with crest and neck feathers down. His neck is curved and his bill pointed down. Both birds are motionless. The male gives the copulation call. The female does not join in the call and may even threaten passing birds. After about half a minute the male slides into the water over the head of the female. There is no post-copulatory display.

The female Great Crested Grebe (Simmons, 1955) holds her head and beak straight out, probably because of her long neck. The male takes the same position as seen in the male Eared Grebe, but the closed wings are quivered as in the rearing soliciting attitude. The call is a harsh rattle "sounding like a creaking ee eee" (Simmons, 1955, quotation of Hanzak). As the male slides off the nest, he takes the escape bathing position except with the crest and head up. He settles and begins head shaking with his back to the female. The female raises her head to head shake with him.

"Escape bathing" was so named by Simmons (1955) because he thought it was a real escape pattern. It is a particularly violent version of the bathing behavior which ends with a peculiar attitude. The body is held upright but half submerged, that is, half the white breast feathers are showing above the water. The neck is arched and the crest down; the chin is on the breast. I have seen this only three times in the Eared Grebe, and Simmons (1955) only five in the Great Crested

Grebe. In all of my Eared Grebe records the pattern followed defeat in a nest establishing encounter. In three of Simmons' records, escape bathing followed aggressive encounters with other grebes; in the other two, it followed an escape dive. Following escape bathing, the Great Crested Grebe puts its head under water and looks around as if looking for something; I did not see Eared Grebes do this. Simmons felt that the grebes were looking for fish predators and that the whole pattern was one of escape. He says that the assumption of this attitude after copulation is a return to escape behavior after this unusually close contact with another bird. I do not doubt that post-copulatory attitude and the escape bathing posture are related. But the upright posture, the arched neck, and the lowered bill are never seen, even separately, in escape behavior. Escape bathing may be derived from the male copulation posture or from the rearing soliciting attitude, but it is probably a carry-over of sexual motivation.

#### *Abandoned Eggs*

When most of the pairs were involved in nest establishment, eggs began to appear. At first they were not brooded but simply abandoned on flimsy platforms. These were "yard eggs" in the same sense as those of galliforms and show readiness of the gonads before maturation of the incubation behavior. The hormonal basis of maturation of incubation behavior in grebes is not known, but it may well be related to increased production of the anterior pituitary hormone prolactin which is known to stimulate broodiness in pigeons and chickens (reviewed in Sturkie, 1954).

The first few days these eggs were not pecked, but after this all eggs found had a hole pecked in the top. Presumably a grebe pair may fight for and gain a platform with an egg, peck the egg, and push it off the nest. Just before final clutches were started on Westwick Lake in 1956 there was a broken egg under nearly every platform, and two under some. I never saw the grebes peck an egg, but the pecks were clearly those of small bills, and pecking was done when no other birds were around the area. The contents were not eaten. As the season progressed, the birds became more and more vigorous in guarding their platforms, and they began to incubate the eggs as they laid them. These incubated eggs were the eggs of the final clutch.

Two clutches of pecked eggs were found in the last week of incubation. One bird of each pair may have died or deserted the nest. Plate \_\_\_ shows an abandoned egg that has been pecked.

Nest-establishment behavior begins about the same time, but it may end as early as May 20 or as late as July 16. On Westwick and Soren-

sen lakes in 1955 clutches were not begun until June 27 and June 22 respectively. 1956 was similar. If June is warm, the tempo of nest establishment rises gradually to a culmination in the laying of final clutches in the early part of June. But usually June is cold and rainy in the study area, and the birds stop all reproductive activity and rest and feed until good weather in July. When good weather returns, a burst of nest establishment activity leads to incubation.

Lack (1933) and Kendeigh (1934) give a number of examples of delay in nesting with unusually cold or wet weather. These delays may be in nest building, laying, or beginning incubation. They are apparently caused by inhibition of nervous mechanisms, because the changes are too sudden to be explained by changes in hormone balance. The selective mechanism presumably works in such a way that young are hatched when food is abundant, according to Kendeigh (1934). Cold weather did not seem to affect the supply of food for the Eared Grebe or its young, as the grebes fed on plentiful insect larvae in the water. But many young died of exposure during the first few days after hatching. If the birds started to incubate during inclement weather, these losses would probably increase.

#### *Clutch Size*

Full clutches varied from one to six eggs, but clutches of one, two, five, and six were relatively rare. The mean clutch size for all nests observed, except those robbed experimentally, was 3.48. Table 2 gives data for all nests where sufficient observations were made to ascertain full clutch size.

TABLE 2

## ACTUAL FULL CLUTCH SIZE

	<i>Total of Clutches</i>							<i>Mean</i>
		<i>c/1</i>	<i>c/2</i>	<i>c/3</i>	<i>c/4</i>	<i>c/5</i>	<i>c/6</i>	
Westwick Lake, 1955 (Marsh colony)	113	1	8	47	45	9	3	3.48
Sorensen Lake, 1955	37	0	0	13	22	2	0	3.70
Total	150	1	8	60	67	11	3	3.59
Westwick Lake, 1956 (Marsh colony, undisturbed nests)	106	0	0	69	33	2	2	3.40
Westwick Lake, 1956 (Willows colony)	15	0	0	14	0	0	1	3.42
Sorensen Lake, 1956	22	0	1	16	4	1	0	3.22
Total	143	0	1	99	37	3	3	3.36

There is a significant difference ( $P = .01$ ) between the distribution of clutch sizes for all nests observed in 1955 and for nests observed in 1956. Sorensen Lake, when the two years are compared, shows a less significant difference ( $P = .05$ ). Westwick Marsh 1956 when compared with Westwick Marsh 1955, shows a significant difference ( $P = .01$ ). The Westwick colonies had many more nests than the Sorensen colonies, so the total figure for the year approaches that for the comparison of the two large Westwick colonies. Significant differences between the clutch sizes of one lake from year to year are indicated.

When two colonies are compared in the same year, there is less difference between them. Westwick compared to Sorensen in 1955 shows no significant difference ( $P = .30$ ). Westwick Marsh 1956 when compared to Sorensen 1956 and to Westwick Willows 1956 shows a slight difference ( $P = .05$ ). Two colonies of birds under the same environmental conditions may, then, have clutch sizes which are significantly different, but the differences are not as great as those between two years of the same colony. The marsh colony was higher in mean clutch size than Sorensen Lake in 1955 and lower in 1956.

#### *Indeterminate Clutch Size*

One fresh egg was taken from each of thirty-two nests within the Westwick Marsh colony in 1956. The environmental conditions (except for the robbing) were exactly the same for robbed and undisturbed nests. Clutch sizes for the robbed nests are shown in Table 3.

TABLE 3.  
INDUCED CLUTCH SIZE (BY ROBBING)

Westwick Lake 1956 (Marsh colony)	No. of Clutches	c/1	c/2	c/3	c/4	c/5	c/6	c/7	Mean
Second egg removed	15	0	5	7	2	1	0	0	2.93
Third egg removed	14	0	5	7	1	0	1	0	2.92
Fourth egg removed	3	0	0	2	1	0	0	0	
Total eggs in robbed nests	32	0	10	16	4	1	1	0	2.97
Total eggs laid	32	0	0	10	16	4	1	1	3.97

The total number of eggs laid in the experimental clutches is significantly different ( $P = .01$ ) from the control clutches in the same colony. In the absence of environmental differences the birds responded to the loss of an egg by replacing it, making up fifty percent of the loss. The same percentage of loss was made up whether the third or the

second egg was taken. The first egg could not be taken because the nest would have been abandoned, and the data for the fourth egg removed are too few for analysis. Lack (1947) and Davis (1955) reviewed the incidence of determinate and indeterminate laying in birds. Columbidae, some Passerines, and many Charadriiformes are strictly determinate. Only the fixed number of oocytes are formed and these are laid whether eggs are taken from the nest or added to it. Many passerines, Anatidae, and Galliformes are indeterminate layers and keep laying until a predetermined number of eggs are in the nest. In these birds laying may not be suppressed by the addition of eggs to the nest. All indeterminate layers and the determinate passerines are to a certain extent variable in their clutch sizes. The Eared Grebe fits into the indeterminate group with those of the passerines which replace only a limited number of lost eggs. The mechanism for controlling the end of laying in indeterminate layers which have not been robbed is apparently not known for any species.

#### *Synchronization of and Intervals between Egg Laying*

Clutches of one colony were all started very close together in time. In the Westwick Willows colony 1956, the first eggs for all 22 clutches started were laid within a four day period. (Only 15 of these lend themselves to clutch size analysis.) Laying of first eggs in the larger colonies was more spread out; in 180 clutches started in Westwick Marsh 1956, all first eggs were laid in a thirteen day period. Darling (1938) found that in gulls larger colonies had a smaller span of first egg dates than smaller colonies. He felt that the greater the number of birds, the greater the stimulating effect of the group courtship, and therefore the greater the synchronization of egg laying. Nest establishment activities must be highly stimulating and those birds which are not yet involved swim back and forth watching. Also egg pecking would seem to hold back the first birds to lay until the whole group is ready. The resulting synchrony, while striking, is not so striking as that seen in Darling's gulls. Perhaps late migrants laid late in the large colony, or possibly the large colony had more young birds which laid late. The clutch size average of late layers was the same as that of early layers.

Darling showed that synchronization in gulls reduced the percentage loss of young by predation. The Eared Grebe seemed to have no predators in the lakes studied, and therefore colonialism and synchronized laying for them serves no purpose in protection of eggs and young.

Data on the interval between eggs in a single clutch are difficult to obtain. In order to get large numbers of records, work was concentrated in the Westwick Marsh colony. Counts took nearly two hours and

could not be made more than once a day for fear of disturbing incubation too much. On cold rainy days they had to be omitted altogether because of the danger of the eggs being chilled. Further studies should include more intensive study of fewer nests. In one four-day period before clutches in these nests were complete, fourteen nests held four fresh eggs, fifteen three, and three nests five. I have three records of two days skipped between eggs and two of three days between eggs. If the normal laying is every day, as it is in most passerines, skipped days occurred in 50% of the clutches. Lunk (1955 unpub.) showed that while Rough-winged Swallows (*Stelgidopteryx ruficollis*) regularly lay every day, 20% of the clutches showed skipped days.

In one instance I made counts in the evening, and the morning and evening of the next day. The following were noted:

1 egg laid between:	no. nests
8:00 P.M. and 10:00 A.M.	15
10:00 A.M. and 8:00 P.M.	13
no eggs whole 22 hours	21

All of these birds laid at least one more egg after this period. Skutch (1952) showed that most of the passerines he studied laid shortly after dawn. A few laid in late morning or very early afternoon. A caprimulgid laid in the afternoon. More detailed data on fewer nests would clarify the situation for the grebes.

#### SUMMARY

The behavior of the Eared Grebe was studied in 1955 and 1956 in the Cariboo Region of British Columbia.

The Eared Grebe has five courtship patterns: an advertising display, habit preening, head shaking, the standing penguin dance, and the peculiar cat attitude. Comparison is made with the courtship patterns of the European Great Crested Grebe, as reported by Simmons. Both sexes have the same displays.

Threat and escape attitudes are described.

Eared Grebes are colonial birds, with remarkable synchronization in the transition of the colony from courtship behavior in early May to nesting behavior in the latter part of the month. When nest-building begins courtship ceases.

During nest establishment groups of birds frequent areas with reeds and floating vegetation, there is a soliciting display, and temporary platforms are made and abandoned. The females appear to do the actual nest building, but the lack of any striking sexual dimorphism leaves room for error. The nest is a floating heap of debris, on a

foundation of reeds, with the slightly rimmed cup rising only an inch or two above the water, so that the eggs are constantly damp. Nests are from one to three feet apart, in water one to three and a half feet deep.

Copulation occurs on the nest from the time the first platforms are made until the end of egg laying.

Eggs are laid and abandoned before the nest is fully built. Full clutches varied from one to six, three or four being usual; mean clutch size was 3.48.

Experiments in the removal of eggs indicate that the Eared Grebe is an indeterminate layer, but replaces only a limited number of lost eggs.

There is considerable synchronization in the beginning of egg laying among birds of a colony, particularly in the smaller colonies. The usual interval between egg laying was not definitely established, but in about 50 per cent of the clutches there was one day skipped, and in some cases two or even three days elapsed between eggs.

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## FOOD REQUIREMENTS OF THE GOLDEN EAGLE

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IN the fall of 1954 a raptor feeding study was undertaken at the Montana Cooperative Wildlife Research Unit, Missoula, Montana. Objectives were to determine the average daily food intake of the Golden Eagle (*Aquila chrysaëtos*), and to observe if the relation of body weight to food consumed by this large raptor varied with environmental temperature fluctuations.

Such information is necessary in the field of raptor predation, for use in estimating the number of prey species required to maintain the predator in its environment. Craighead and Craighead (1956: 318-320) have obtained such data for a number of the smaller raptors and applied these to express the number of prey individuals consumed by a raptor population. No work of this nature has previously been done with the Golden Eagle.

## METHODS

Three Golden Eagles and one Goshawk (*Accipiter gentilis*) were kept from the fall of 1954 to the summer of 1955. One eagle was retained for the following year also. The birds were kept out-of-doors exposed to natural climatic conditions. They were handled, fed, weighed, and cared for using the techniques of Craighead and Craighead (1956: 312-313). Each bird was placed on a perch and secured with jesses and a leash. By "bating off" the perch (beating the wings continually) at intervals the birds received a considerable amount of daily exercise. It was not uncommon for the eagles to "bate off" and exercise their wings until fatigued.

By controlled feeding, each bird was initially brought to a body weight where it was "eager" for food, but not starving; then the daily ration was regulated to maintain the birds at these weights. It proved to be a more difficult task to hold the eagles at constant body weights than the smaller Goshawk. The data in Tables I through III show that the change in body weight of the experimental eagles from the beginning to end of a feeding experiment varied from a loss of 54 grams to an increase of 75. A change of this magnitude is relatively insignificant. For the purposes of these experiments we can consider that the body weight of the eagles remained relatively constant during the feeding periods, since by the inclusion of several final feedings or the exclusion of a similar number the initial and final body weights would have showed little or no change.

The diet consisted primarily of venison during the fall and winter

months, with a mixture of chopped venison and chicken heads being fed once a week to provide the necessary roughage and minerals. During the spring and summer months the staple diet was changed to horse meat, and the roughage requirements were obtained primarily from wild rodents.

Feeding took place once each day in the afternoon at a prescribed time. The birds were weighed at least once a week prior to the day's feeding.

Golden Eagle 2, which was retained from the summer of 1955 to the spring of 1956, was trained and exercised during a 24-day interval of warm summer weather and for a 29-day interval during cold winter weather. The eagle was flown from its perch to the gloved hand. After each flight it was rewarded with food. One long flight or several shorter flights constituted the daily flight exercise. These distances were paced off and recorded.

The Goshawk was fed under the same conditions, so data obtained could be compared with the work of Craighead and Craighead (1956: 412-413) and in turn used as a check and reference for any variation that might be found in the larger raptors. The maximum and minimum temperatures were recorded each day at the study site.

#### RESULTS

From the fall of 1954 to the spring of 1955, food consumption data were obtained from all four birds. During this time they were not flown, but did obtain exercise by "bating off" the perches. The per cent of body weight eaten by the eagles (Table I) ranged from 5.7 per cent for the larger female (No. 3) to 6.6 and 6.5 per cent for the smaller males (Nos. 1 and 2). During this same period the Goshawk consumed daily an amount of food equal to 14.1 per cent of its body weight. This figure for the Goshawk agrees quite closely with the data compiled by Craighead and Craighead (1956: 412-420) for raptors of a similar size. The Craigheads (1956: 314, 413, 420) also related the food consumed by large and small raptor species to their respective body weights. They showed that the large raptor species daily consumed less food in relation to body weight than did the smaller raptors. The percentage of food eaten by the eagles in this experiment shows this same general trend (Table I). This is also evident when the data for the large female (No. 3) is compared with that for the two smaller male eagles (Nos. 1 and 2). This may well be a manifestation of a lower basal metabolic rate in the larger raptor species and possibly also reflects a difference in basal metabolic rate between male and female of the same species.

TABLE I  
FALL AND WINTER FOOD REQUIREMENTS

<i>Feeding Dates</i>	<i>Raptor Species</i>	<i>Sex and Age</i>	<i>Ave. Wt. of Max. Daily Food Eaten per Day, gms.</i>	<i>Ave. Wt. of Raptor, grams</i>	<i>% Ave. Body Wt. Eaten per Day</i>	<i>Ave. Temp. °P.</i>	<i>No. Days Fed</i>	<i>Change in Body Wt. gms.</i>
11/7/54 to 3/30/55	Golden Eagle 1	Ju.M.	524	266	4026	6.61	27.8	+143
11/7/54 to 3/8/55	Golden Eagle 2	Ju.M.	388	262	4059	6.47	27.7	+121
	Golden Eagle 3	Ad.R.	562	308	5436	5.67	27.7	+121
	Goshawk 4	Ad.M.	267	124	880	14.1	27.7	-36

TABLE II  
COMPARISON OF FOOD REQUIREMENTS DURING WARM WEATHER PERIOD  
WITH AND WITHOUT EXERCISE

<i>Feeding Dates</i>	<i>Raptor Species</i>	<i>Sex and Age</i>	<i>Ave. Wt. of Max. Daily Food Eaten per Day, gms.</i>	<i>Ave. Wt. of Raptor, grams</i>	<i>% Ave. Body Wt. Eaten per Day</i>	<i>Ave. Temp. °P.</i>	<i>No. Days Fed</i>	<i>Change in Body Wt. gms.</i>
6/28/55 to 7/31/55	Golden Eagle 2	Ju.M. without exercise	290	188	3572	5.26	64.8	-54
8/17/55 to 9/10/55	Golden Eagle 2	Ju.M. with exercise	361	231	3324	6.94	65.3	-3

TABLE III  
COMPARISON OF FOOD REQUIREMENTS DURING COLD WEATHER PERIOD  
WITH AND WITHOUT EXERCISE

Feeding Dates	Raptor Species	Sex and Age	Ave. Wt. of Max. Daily Food Eaten Wt. of Ration, gms.	% Ave. Body Wt. Eaten per Day of Raptor, gms.	Ave. Temp. °F.	No. Days Fed	Change in Body Wt. gms.
11/7/54 to 3/8/55	Golden Eagle 2	Ju.M.	388	262	4059	6.47	+30
11/15/55 to 12/14/55	Golden Eagle 2	Ju.M.	294	253	3864	6.55	+75
without exercise	with exercise						

TABLE IV

Feeding Dates		Data on Exercise of Golden Eagle		Data on Non-Exercise of Golden Eagle	
8/17/55 to 9/10/55		Ave. Distance Flown per Study Day, yds.	Ave. Distance Flown per Day Exercised, yds.	Ave. Distance Flown per Day Eaten, yds.	Ave. Distance Flown per Day Fed, yds.
11/15/55 to 12/14/55	(app.)	250	275 (app.)	816 (app.)	917
	(app.)	647	793		79.3

TABLE V

RELATION OF FOOD CONSUMPTION TO TEMPERATURE							
Feeding Dates	Raptor Species	Sex and Age	Ave. Wt. of Max. Daily Food Eaten Wt. of Ration, gms.	% Ave. Body Wt. Eaten per Day of Raptor, gms.	Ave. Temp. °F.	No. Days Fed	Change in Body Wt. gms.
10/28/54 to 12/7/54	Goshawk 4	Ad.M.	186	120	906	13.2	-43
11/14/54 to 11/21/54	Goshawk 4	Ad.M.	164	103	917	11.2	-42.6
11/7/54 to 3/8/55	Goshawk 4	Ad.M.	267	124	880	14.3	+34
12/5/54 to 2/2/55	Goshawk 4	Ad.M.	162	126	879	14.3	-36
12/8/54 to 1/8/55	Goshawk 4	Ad.M.	162	129	879	14.6	-6
11/7/54 to 3/8/55	Golden Eagle 2	Ju.M.	388	262	4,059	27.7	+7
6/28/55 to 7/31/55	Golden Eagle 2	Ju.M.	290	188	3,572	5.47	+33

Data for eagle No. 2 during the warm weather period without exercise (6/28 to 7/31, Table II) when compared with data from the cold weather period without exercise (11/7 to 3/8, Table III), show that the per cent of body weight consumed decreases with an increase in the average daily temperature. This also is in agreement with the work by the Craigheads (1956: 412-413). However, upon comparing the per cent of average body weight eaten per day in warm weather with no exercise, against the per cent during a comparable warm weather period while the bird was being flown to the hand (Table II), it appears that this relatively small amount of exercise had a marked effect on the food consumption. On the other hand, comparison of the cold period data with and without exercise (Table III) does not illustrate a similar increase in food consumption due to exercise. This is even more striking since the amount of exercise per day during the cold period was almost three times that of the warm period, if distance of flight is assumed proportional to amount of exercise (Table IV).

The Golden Eagle was moulting during the summer months. Falconers have long suspected that food consumption of raptors increases due to nutritional demands of the moult. Although there appears to be no quantitative data in the literature to support this, we have much evidence that this is true. We suspect that the additional food required to grow new feathers masked any response to exercise and that what appears as a marked response to exercise is largely a response to the peak of the moult.

The smaller Goshawk also followed the pattern of the inverse relationship between temperature and food consumed, although a smaller fluctuation in temperature produced a much stronger response in the bird's food consumption (Table V).

This response in both the Golden Eagle and the Goshawk can be compared in Table V. These data can also be compared directly to similar data computed for other raptors by Craighead and Craighead (1956: 413).

#### APPLICATION

The data presented in Table I can be used in calculating the number of prey species required to maintain a pair of Golden Eagles or a known population of them.

In order to do this with some degree of accuracy it is necessary to have the following information: 1. The number of eagles and the length of time they are present on a given area of land. This can then be expressed as raptor-days. 2. An adequate sample of the eagles' food in the wild. 3. The average weights of major prey species available to the eagles. 4. The quantitative food requirements of Golden Eagles.

The procedure to be followed in making a calculation of this nature is presented in detail by Craighead and Craighead (1956: 311-326). All the information needed to do this for the Golden Eagle is not at present available, but the authors hope the data on food requirements here presented will inspire other workers to obtain the needed information and make the calculations. Such information appears essential if we are to understand better the role of the Golden Eagle and other raptors in regulating numbers of prey animals.

#### CONCLUSIONS

The ratio of the weight of food consumed by the Golden Eagle, expressed in per cent of its average body weight, varies inversely with respect to both the body weight of the individual bird and the environmental temperature. An adult female required an average daily ration during the fall and winter of 308 grams and two juvenile males required 262 and 266 grams respectively during the same seasons.

The per cent of average body weight eaten per day by the Golden Eagles lay between 5.5 and 6.6. The smaller Goshawk consumed 14 per cent of its average body weight during the cold weather period. Although the effect of exercise cannot be conclusively shown by this work, it is supposed that food consumption would increase slightly with exercise.

The data presented, when related to other vital statistics of diet, raptor-days, and average prey weights, can be used to estimate the number of prey animals of various species required to maintain these raptors in their environments.

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## PAIR FORMATION, MUTUAL TAPPING AND NEST HOLE SELECTION OF RED-BELLIED WOODPECKERS

BY LAWRENCE KILHAM

This paper describes pair formation, nest hole selection and the early breeding cycle of the Red-bellied Woodpecker (*Centurus carolinus*) as observed in the vicinity of Seneca, Maryland, beginning with the first signs of breeding behavior in January until the actual nesting in April. Features such as reverse mounting, a hitherto undescribed performance here called mutual tapping, vocalizations and drumming are also discussed. I did most of my observations in bottomlands along the Potomac River, when the woods were bare of foliage, in 1956, 1957, 1958.

### ONSET OF BREEDING BEHAVIOR

Families of Red-bellied Woodpeckers break up in late summer and individuals become distributed singly over the countryside. It is rare to find a male and female together between September and January. The birds are relatively quiet during the autumn. In September and October, 1956 I heard no drumming from Red-bellies, and the vocalization "kwirr" on only two days when males were apparently in conflict over roost holes. During the late fall I watched several roost holes at dawn. The males invariably left their roosts without pausing, and flew off with little noise. The females had their own roost holes.

In 1956 signs of an autumnal recrudescence of breeding behavior (if such it was) were limited to one observation. On a warm day, November 9, a male flew to a dead stub and gave three sets of slow, rhythmical taps. A female appeared, gave a "chrr" note, joined briefly in the tapping and was gone. The loud "kwirr" so characteristic of the male during the breeding season was not uttered. The stub where this incident occurred had a small hole apparently owned by a Downy Woodpecker (*Dendrocopos pubescens*), which after the tapping drove the male Red-belly away.

The onset of the breeding cycle seems to be signalized by the loud persistent "kwirr" of the males, which rings out at dawn on the coldest days after the middle of January. In 1955, 1956 and 1957 this call was first heard in mid-January. At about the same time the male starts to drum. A male will generally call from his roost hole or from a potential nest hole. A female may fly to him from her separate roost hole. In 1957 I did not notice males taking an interest in potential nest holes until January 26.

During the severe winter of 1957-58, especially when mid-December snow storms broke a long period of mild weather, Red-bellied Woodpeckers deviated somewhat

from patterns of behavior which I had observed the previous year. Though the male Red-bellies had been relatively quiet all fall, they began calling after the snowfall as ardently as in spring. On December 15, when I walked into Seneca Swamp over snow and ice in the early morning sun, I heard almost frantic "kwirr, kwirr, kwirr" calls from many directions. The sound of mutual tapping (Figs. 1 and 2; see p. 320) came clearly on two occasions. The sound appeared to come from a willow stub with a hole in it. A male drummed a number of times on a nearby pole, where a nesting male had drummed during the previous spring. A neighboring male called "kwirr" and drummed from a succession of dead stubs and branches. Two other males were starting excavations, which, as far as I could observe, were completed over the next four to six weeks. The intensity of this mid-December activity greatly subsided within a week. After a short spell of mild weather, January 1958 was unusually cold and windy and I heard almost no "kwirrs" until February.

#### SEPARATE ASPECTS OF BEHAVIOR IN EARLY PAIR FORMATION

**Drumming.** When drumming, male Red-bellied Woodpeckers give a roll, lasting close to a second, which is so rapid that one has difficulty determining the number of individual blows—possibly about six a second. An unmated male drummed every 5 to 10 seconds for a few minutes. Pauses between drums, however, can be irregular and interrupted with "kwirrs." In 1957, males began drumming in January, at the time of their first "kwirrs." Drumming might be occasioned by a variety of circumstances. Thus, with the Pennfield pair (*infra* p. 324), the female flew to the male on three different days when he was drumming and coition or reverse mounting soon followed. Lone male Red-bellies might drum and "kwirr" alternately in an apparent effort to attract a mate. Males scattered over the countryside often seemed to drum in response to other males and they continued to do so while nesting was in progress. Drumming went on occasionally during the summer. However, I heard none from Red-bellies during the fall when the drumming of Pileated Woodpeckers (*Dryocopus pileatus*) or of Flickers (*Colaptes auratus*) could be heard on any early morning. Female Red-bellied Woodpeckers drum infrequently. I saw a female drum only once, on April 20, 1957, when a pair was much excited over Starlings, which were trying to take over their nest. The pair called and gave mutual taps also. This could have represented "displacement" activity.

**Mutual Tapping.** Tapping consists of blows given at a rate of about three per second. The beats in tapping are countable and slow. Tapping is readily distinguished from drumming, which is a much more rapid, blurred roll. Males, apparently trying to attract a female to an excavation or potential excavation, may tap alone many times, in addition to calling "kwirr" and occasionally drumming. If attracted, the female

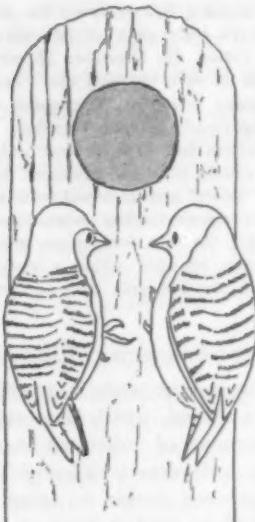


FIGURE 1. When starting a new excavation, the pair of Red-bellied Woodpeckers tap together outside of the hole.

may go to the same tree as the male and, alighting beside him, join in mutual tapping (Fig. 1). Sometimes the male may tap within the excavation and the female outside it (Fig. 2B). Mutual tapping lasts on the average for about two seconds, but its duration is somewhat variable, and it may be repeated. The tapping is essentially synchronous, but not perfectly so. This performance was observed 30 times in the spring of 1957—often when a pair was selecting or excavating a potential nest hole. Mutual tapping may occur early in the season. On February 23, 1958 I heard a pair repeatedly engage in bouts of mutual tapping. I never noted it once actual nesting had started within an excavation.

*Examples:* A pair of Red-bellies began an excavation on the under side of a dead limb of a pin oak (*Quercus palustris*) where they were molested both by Starlings and a Red-headed Woodpecker (*Melanerpes erythrocephalus*). On March 24, 1957 the pair seemed to have moved about 40 feet away. At 6:45 a.m. I saw the female giving strong, rhythmical taps alone. In the next 15 minutes I heard mutual tapping three times in the same vicinity. I could find no excavation. Possibly I had not been quick enough, for it is difficult to spot a situation through intervening trees. On the next week-end, however, I found the male where I had heard the tapping; he was excavating a new hole in a dead maple. Next morning

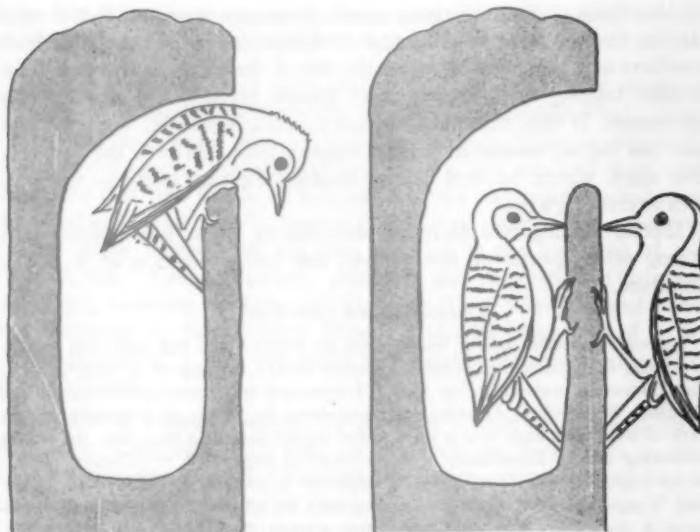


FIGURE 2. Mutual tapping of Red-bellied Woodpeckers. (A) Male calls "kwirr" from entrance of his roost hole at dawn, raising crest and pointing bill toward ground. (B) Male starts to tap inside as his mate alights and joins in the tapping.

mutual tapping took place twice on this stub. As usual in such excavations, the female excavated once the male had the hole well started.

On February 23, 1958 I located on a dead elm stub a pair which had been engaged in mutual tapping. By this time a second male had appeared and tapping ceased. Twenty minutes later the first male was alone on the stub. He tapped several bursts, then "kwirred" with some intensity, and drummed. Within a few minutes a female alit at his level, which was by a new, shallow excavation. Both birds rested in the same positions for the next 20 minutes, motionless except for occasional bursts of mutual tapping.

On March 30, 1958, I observed a male Red-bellied Woodpecker clinging to a dead elm eight inches below an abortive excavation of Pileated Woodpeckers. When close, I heard the Red-belly give nine bursts of tapping, interspersed with "kwirrs." The bursts included from 4 to 12 taps. After the nine bursts, the male called "kwirr" over and over, stretching head and bill upward as he did so. Then the female suddenly alit close to him and about five mutual taps followed. She flew away shortly afterward. The male, however, remained motionless and quiet in the same place where I had first observed him, for the next ten minutes. On the basis of this and similar episodes, I believed that the birds were performing at a potential nest site.

I sometimes noticed Red-bellies pecking here and there on bark below an excavation. Possibly they were percussing to ascertain the degree

of soundness of the underlying wood. One may speculate that mutual tapping evolved as an amplification of this procedure. Presumably both members of a pair must agree on the site of their prospective nest hole. Mutual tapping may, among other things, register and express this agreement. It thus stimulates the pair to work in unison. Once excavation has begun, continued mutual tapping may reinforce the cooperative spirit which, in final stages, enables the two birds to work in turn at creating a nest.

Mutual tapping is a dramatic performance. I have not observed it among other species of woodpecker, nor found mention of it in the literature.

#### *Comparison with other Species*

Intercommunication among woodpeckers by means other than calls and regular drumming is not unknown. Thus de Villiers (1957), writing of an experience in East Transvaal, states that "on June 1, I witnessed an intercommunication of two Cardinal Woodpeckers (*Dendropicos fuscescens*) by means of drumming on the bark of trees. The male beat a rapid tattoo on the bark of a dead tree, the female answering almost immediately with an identical tattoo \* \* \*." Tanner (1942), in his report on the Ivory-billed Woodpecker (*Campephilus principalis*), wrote that "Ivory-bills \* \* \* signal by pounding with the bills on limbs and stubs, sometimes a single hard blow, but more often a hard, double rap, *bam bam* \* \* \*. They frequently double rap when disturbed \* \* \* or when one of the pair is absent." When members of a pair changed places at a nest "One would \* \* \* signal the other by calling or pounding. We occasionally heard the setting bird answer by pounding on the inside of the cavity."

*Coition and Reverse Mounting.* During winter and spring of 1957 I observed what appeared to be coition 11 times. Mounting by males was noted as early as February 7, which was two months before eggs were laid in my area. The early mounting by the male is probably only pseudo-coition. In full coition, as seen prior to egg-laying, the male starts well-mounted, then gradually falls off to the left side and somewhat backward, the whole process being notably longer than the abortive type.

Reverse mounting, in which the female fluttered on the male's back, I saw on nine occasions in 1957. It was noted as early as February 23 (see p. 326); on five occasions later in the year reverse mounting immediately preceded coition.

Coition and reverse mounting might be preceded by drumming or mutual tapping. In my experience a constant feature preceding reverse mounting was that the female flew to the male. She usually came as he called at a nest excavation, but in a few instances, as in the Pennfield pair discussed later (p. 324), she came to a drumming tree.

Example: On April 27, at 6:40 a.m. a male Red-belly was calling "kwirr," at the nest hole in a willow stub. The female flew to him and coition took place.

From 7:22 to 7:30 she flew to him three more times and on each occasion fluttered on his back in reverse mounting just prior to real coition.

Reverse mounting takes place among other birds. I have observed it in a pair of hand-raised hornbills (*Bucanistes subcylindricus*). Glick (1954) has described it prior to coition in Starlings (*Sturnus vulgaris*). He observed reverse mounting several times a day for four days, and concluded that "the female of this pair solicited copulation by imitating the treading of the male." Beach (1948: 65-67) states that mounting by the female of the male has been reported in the courtship of the Great Crested Grebe, *Podiceps cristatus*, the Water-Hen (Common Gallinule), *Gallinula chloropus*, the Common Tern, *Sterna hirundo*, and less frequently in the Domestic Pigeon, *Columba livia*; as well as in certain mammals. I have not found a description of reverse mounting in woodpeckers.

*Behavior of unmated males.* To attract a female an unmated male calls from a potential nest hole, as observed for two males in the winter and spring of 1957. The first of these woodpeckers had begun an excavation in a sycamore (*Platanus occidentalis*) by February 10. He became the noisiest Red-belly in the area, calling "kwirr, kwirr, kwirr" every 10 to 20 seconds. A female suddenly appeared on the morning of February 24. He gave excited "kew, kew" notes and flew to meet her in mid-air. She soon flew away. By March 4 the male had still made little progress either on the excavation or, as I thought, on the attraction of a mate. That morning he called "kwirr" 60 times in a row. A female then alit on a neighboring limb and called "quer." The male immediately started to tap, but she failed to join in. Affairs had apparently progressed by the following morning, for at 7 A.M. I saw mutual tapping on the sycamore, after which the female flew to a nearby limb. He immediately followed and coition took place. Five minutes later the pair had another episode of mutual tapping. Successful nesting was prevented when Starlings took over the excavation a few weeks later.

A second unmated male called repeatedly from the beginnings of an excavation in a willow stub. On April 20, he got two replies in one morning. First, a female came from the east, joined in mutual tapping, then flew back the way she had come. The male continued to call. Then another female approached, from a westerly direction. He flew to her, his plumage fluffed out in excitement, but she returned the way she had come. Two weeks later the male was still alone and his excavation unfinished.

I suspect that this second male had called up two already mated

females on April 20. I had been observing two pairs of Red-bellies which were his immediate neighbors on the east and west. Both of these pairs were disturbed by Starling interference on April 20 and the males comparatively subdued. Thus it is possible that their mates, due to these disturbances, were attracted momentarily by the loud, persistent "kwirrs" of the neighboring unmated male.

*Display.* Male Red-bellies commonly erect the red-feathers on their crowns when excited in the breeding season. On a single occasion I saw an unmated male float down to a drumming limb, with wings held stiffly at a 45 degree angle. The most striking displays were threatening in nature and arose when a third Red-belly intruded on a pair already formed. Thus on April 27 I was watching a pair of Red-bellies which were obviously mated, as indicated by repeated coition and mutual tapping. A second female suddenly alit by the male. The male froze in awkward posture with tail fanned and bill pointed upward. His mate now flew near and he immediately raised his wings, fully outstretched, over his back. This was a beautiful display. I witnessed a similar performance on two other occasions when an intruder came to a mated pair.

A chance observer, seeing a male woodpecker in full display before two females, might easily call the performance courtship. Prolonged observations on Red-bellies, however, gave background for a different interpretation. Threat display may be more spectacular among woodpeckers than pair formation. I have observed this among Downy Woodpeckers, and Noble (1936) found a similar situation in his study of courtship in the Flicker. He states that the so-called "dance" of these birds, in which they call "we-cup," wave bills in the air, and spread their uptilted tails, is "obviously intimidatory."

#### NEST HOLE SELECTION AND EARLY BREEDING BEHAVIOR OF A SINGLE PAIR

The interplay of the various aspects of breeding behavior is best shown by following the activities of a single pair. On February 3, 1957 I began a special study of a male calling repeatedly "kwirr" from a hole 60 feet up in a dead stub of a living silver maple (*Acer saccharinum*), near the Pennfield Locks on the Chesapeake and Ohio Canal (Fig. 3). Thereafter and until April 13 I came at dawn on many days to watch this male and his mate. Their behavior during the period of observation fell into three phases.

*Phase 1. Behavior at winter roost hole.* On February 3 I heard "kwirrs" and drumming in the direction of the silver maple. The male Red-belly flew into the hole at 7:40 A.M., rested with head looking out,

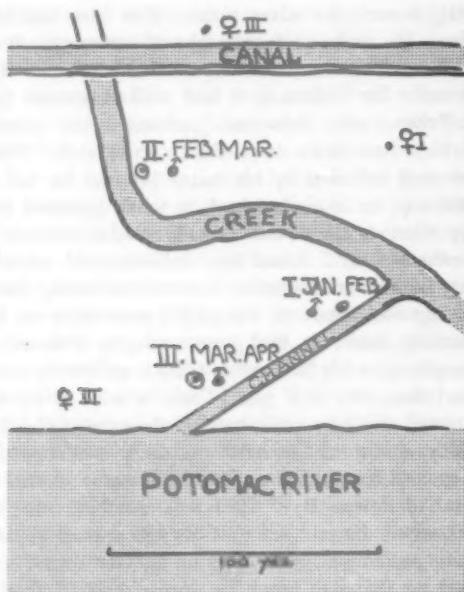


FIGURE 3. Area occupied by a pair of Red-bellied Woodpeckers early in the breeding season. Roman numerals show how the male ( $\delta$ ) moved from his original roost hole (I) to two successive excavations (II and III) in the months indicated. The female ( $\varphi$ ) changed her roost hole also, each time preceding the male to a new vicinity (II and III).

called "kwirr" twice, then suddenly dropped from sight. To my surprise, he gave a slow, clear tapping from the inside. A female Red-belly appeared immediately as if on signal, and, alighting below the entrance, tapped simultaneously (see Fig. 2B). The female flew away after a few moments. Her mate reappeared within the entrance and called "kwirr" 8 times, each time pointing his bill toward the ground and raising the feathers of his crown (Fig. 2A). This posture exposed the red of head and nape to its full extent. The male disappeared from sight for a second time and the female flew in as before to join in mutual tapping. This rhythmical tapping was so distinctive that I later learned to recognize it at a hundred or more yards.

On February 7, the hole in the silver maple was dark and empty before dawn. At 7 A.M., the male looked out and gave a rapid "chaa-aa-aa" followed by a few "kwirrs." His mate replied with a flat "quer" from her roost hole across the creek (Fig. 3) and within a few minutes

she flew directly toward the silver maple. Her mate had been looking in her direction. He dropped from sight at her approach and mutual tapping took place when she lit on the outside of the cavity. It lasted about ten seconds. By 7:20 A.M. I had walked around to the canal. Here a loud "chee-wuck, chee-wuck" attracted my attention to the Red-bellies, which had flown to a dead locust stub. The male was inching up the stub followed by his mate. He had his tail spread and, on reaching the top, he lit on her back in what appeared to be coition. (I cannot say whether there was actually cloacal contact.) This was over two months before I found any indication of actual egg-laying among 11 pairs of Red-bellies under observation during the spring.

Mutual tapping took place at the male's roost hole on February 10 and 13. Something, however, had gone wrong by February 16th. The male, for example, gave his "kwirr" at 6:50 A.M. but his mate answered only "cha" and then only at 7 A.M. From what I could discover, she had already moved to a new roost hole by the canal (Fig. 3). He tried to attract her by continued "kwirrs," and he even dropped from sight to tap alone four different times. She never came to the silver maple until after he had flown. By 7:20 I was watching him on the dead locust. In silhouette, I could see that his bill opened slightly and that his whole body puffed out each time he called "kwirr." The female now responded by flying to him. He spread his tail feathers and attempted coition.

The female called "quers" from her new direction on February 20 and 22, but did not fly to her mate's roost hole. A final dawn performance took place on the following day. After mutual tapping the pair inched to the top of stub in the silver maple and she fluttered on his back in reverse mounting.

*Phase 2. First Excavation.* On February 24 I discovered that the male was excavating a new hole. It was in the direction in which his mate had moved a week previously and was located fifty feet up near the top of a dead birch stub (Fig. 3). He paused to call "kwirr," moving ten feet away as he did so. The female suddenly flew to the new hole to tap at the entrance alone. I returned at dawn on the next morning. At 6:40 A.M. the male put his head out from the hole and gave a low "kwirr." She immediately replied with several "quers," then flew directly to him as he disappeared from sight. I could see her tapping when she alit below the entrance, but I heard no tapping from the male. Possibly the new hole was not large enough for him to maneuver. Similar events took place on March 2 and 3. On March 4, however, I heard mutual tapping full and clear when the female flew from her roost hole to the male's at 6:30 A.M. The male afterward flew

to his dead locust and drummed ten times in five minutes. Then, as on other days, his mate flew to join him. Moving up from behind, she fluttered on his back in reverse mounting.

The newly excavated hole was well established when I left for an absence of three weeks. Starlings had taken over by the time I returned and the Red-bellies were on a third cycle of behavior.

*Phase 3. Second Excavation.* After being driven from his excavation the male had returned to his winter roost hole in the silver maple. On March 24, he emerged at 6 A.M., "kwirred," then dropped back inside to tap alone. His mate did not come. Nor did she appear when I watched again two days later. On April 6 breeding behavior was on the upswing once more and I found the male calling "kwirr," while clinging to the bark by his roost hole, at about 6 A.M. His mate answered from down by the Potomac (Fig. 3). She "quered" four or five times and did most of the calling in the next ten minutes. The male meanwhile drummed half-heartedly and finally flew away. I now went to the other side of the creek to discover, if possible, where the female had called. I not only found a fresh excavation but also the male. He started to tap as his mate lit close by to join in the first mutual tapping which I had witnessed for some weeks (Fig. 1). The male then started excavating with head and shoulders in the new hole. Next morning there was little light when I arrived. At dawn I watched the male emerge from the same winter roost hole where I had first observed mutual tapping, sixty-five days before. His mate started the day by flying, not to him, but directly to the new hole. He came to work on the excavation only after twenty minutes of preening and drumming. He paused while excavating to call "kwirr." She was some distance away, but she answered "quer" immediately and flew to him. Both birds now joined in mutual tapping, just below the hole (Fig. 4). He tapped twice as long as she did. The female then took a turn at excavating.

By April 10 the male was roosting in the excavation. He called eagerly at dawn, came out to drum, then returned inside to look out expectantly. Four Starlings were clinging on the top of his stub. His mate appeared disturbed and would not come close. Three days later I saw the pair of Red-bellies tapping together for the last time. They had deserted their hole by the following day. The Starlings had displayed their usual strategy of waiting until an excavation was complete before beginning active interference.

The pair of Red-bellied Woodpeckers had gone through three cycles of behavior in association with three potential nest holes. In each cycle breeding behavior would reach a crescendo, as marked by the intensity

of their calls and mutual tapping. Starlings twice interfered at this stage. When the Red-bellies began to lose interest and their ceremonies diminished in intensity, it appeared as if the female wanted to move. She seemed to transfer her attention to a new site. The male would continue to stay by the old hole, calling to her in vain. The gamut of breeding behavior began to rise in intensity once he had begun excavating at the new site.

Skutch (1943), writing of the related (Wagler's) Red-crowned Woodpecker, *Centurus subelegans* (=*rubicapillus*), states that the male's winter roost is usually sounder than that of the female and that "it was natural that when the birds began to breed in February it should be chosen for the nest in preference to the female's. Now the female upon leaving her own dormitory in the morning would come to visit her mate's . . ." Skutch does not mention anything resembling mutual tapping.

It is too early to reach definite conclusions, but my present impression is that calling, drumming, and mutual tapping may be used in various situations. Drumming, for example, may serve an unmated male to attract a mate, a paired male to strengthen the pair bond, any male to advertise his nesting area, or an over-excited bird of either sex as a displacement activity. All of these situations may also bring forth calls and sometimes tapping.

#### SUMMARY

Observations made on the early breeding cycle and related behavior of Red-bellied Woodpeckers may be summarized as follows:

1. Onset of the breeding cycle in winter was signalized by males calling "kwirr."
2. A female might fly from her roost hole to that of her mate, in response to his calling at dawn.
3. In mutual tapping, a ceremony which may strengthen the pair bond and register agreement on the site of a nest hole, both members of a pair give slow, rhythmical taps. This performance was observed a) with the male inside his roost hole and the female outside, at dawn, and b) with both birds on bark outside of a hole about to be or being excavated.
4. Mutual tapping was not encountered during actual nesting.
5. Coition a) was apparently solicited by the female, b) was not infrequently preceded by reverse mounting and c) seemingly took place several months before the onset of actual nesting.
6. Unmated males drummed and called "kwirr" in a persistent fashion from incomplete excavations.

7. Paired males started excavations and their mates joined in the work only when the hole was well begun.
8. Females drum rarely in comparison with males.
9. Starlings were severe competitors of Red-bellied Woodpeckers and frequently forced them to abandon excavations at the time of their completion.
10. Red-bellied Woodpeckers were relatively quiet and solitary during the fall. A dramatic but transient outburst of "breeding" behavior took place in mid-December, 1957, following the first snow-storm of the winter.

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REMARKS ON THE TAXONOMY OF SOME  
AMERICAN DOVES

BY DEREK GOODWIN

In the course of current examination and re-arrangement of the pigeons in the collection of the British Museum (Natural History) certain conclusions have been reached on the status of several American genera, which somewhat differ from current treatment.

**Zenaida, Zenaidura, Nesopelia, Melopelia**

In his catalogue of the pigeons Salvadori (1893) listed the four genera *Zenaida*, *Zenaidura*, *Nesopelia* and *Melopelia* in his sub-family *Zenaidinae*. He distinguished the first two as having "moderate and straight" bills and fourteen tail feathers, the tail of *Zenaidura* being "rather long, graduated or cuneate" and that of *Zenaida* "moderate and rounded". *Nesopelia* (containing the Galapagos Dove) he characterised as having twelve tail feathers, a "rather short and rounded" tail and the bill "rather long and much bent downwards", *Melopelia* (the White-winged Dove) on its lack of certain signal markings and possession of others, and also on slight differences in the shape of the inner webs of the first two primaries. Ridgway (1916) followed this classification. Peters (1934) pointed out that only one of the species, the South American *auriculata*, placed in *Zenaida* by these authors had in fact fourteen tail feathers, the others having twelve. He accordingly placed *auriculata* in the genus *Zenaidura*. He made *Melopelia* congeneric with *Zenaida*, remarking that he had looked in vain for any characters "of generic value" to separate them. He maintained *Nesopelia* by reason of its "short tail . . . and strongly decurved bill". Hellmayr and Conover (1942) followed Peters, placing the Mourning Dove *Zenaidura macroura* (Linnaeus) and the Eared Dove *Z. auriculata* (Des Murs) in *Zenaidura*; the Zenaida Dove *Zenaida aurita* (Temminck) and the White-winged Dove *Z. asiatica* (Linnaeus) in *Zenaida*, and the Galapagos Dove *Nesopelia galapagoensis* (Gould) in the monotypic genus *Nesopelia*. The A.O.U. Check-list (1957: 260-262) similarly separates *Zenaidura* and *Zenaida*.

I feel diffident about "lumping" genera, but in this instance there seems to be justification for so doing. Generic limits are largely a matter of opinion and one's opinion is guided by an appraisal of characters and the way in which other species in the same family are, or can best be grouped into genera. A genus need not consist of a discrete group (Cain, 1956) and if, as is the case with the fruit-doves of the genus *Ptilinopus* for example, it is a natural group it need not be capable of definition by

even a single character common to everyone of its members (Cain, 1954). In the current arrangement (Hellmayr and Conover, *loc. cit.*) the genus *Zenaidura*, consisting of *macroura* and *auriculata*, differs from *Zenaida*, species *aurita* and *asiatica*, in possessing an extra pair of tail feathers and proportionately slightly smaller feet and tarsi. I do not think the possession of fourteen instead of twelve rectrices can be considered a valid reason for separating into different genera two species which are so alike in their characters as are *auriculata* and *aurita*. The same view has been expressed by Bond (1940: 53, footnote 33). In coloration, and especially in detail of color-pattern, there is a great deal of uniformity in the species of both genera. All have a blackish band across the lower part of the face with an iridescent patch on the neck immediately behind it and similar and homologous tail markings. There are also black spots on the wings, although in *asiatica* these are reduced to traces of spots on the concealed basal portions of the feathers, suggesting, as was pointed out by Whitman (1919), that their reduction occurred comparatively recently in their evolutionary history. Another feature also lacking only in *asiatica*, is a black mark extending from the corner of the eye. In my opinion these plumage characters, which are correlated with a general similarity of size are, in this instance, of greater phyletic importance than the differences in the length, shape and number of feathers in the tail. This conclusion is emphasised by the fact that the tail of *auriculata* (genus *Zenaidura*) is intermediate in length and shape between those of *macroura* and *aurita* (genus *Zenaida*).

Similarly the Galapagos Dove, *galapagoensis*, does not appear to be sufficiently distinct for generic separation. Its tail is only a little shorter than that of *aurita*. Its bill (as so often in island forms) is relatively larger and the culmen perhaps slightly more curved, but these differences of bill size are not greater than those often found between races of a single species. There seem to be no grounds for Peter's opinion that "Its affinities are not clear" or that it bears only "a faint general resemblance" to *aurita* and *asiatica*. It does in fact bear a strong resemblance to *aurita* and there can be very little doubt that both have derived from a common stock. Whitman (1919) suggested that *galapagoensis* represents a form ancestral to both *aurita* and *asiatica*. He pointed out that the profuse black and white markings on its wings could well be the "raw materials" from which the signal markings on the wings of *aurita* and *asiatica* have been developed. It seems probable that the short tail and large bill are adaptations to its island habitat rather than ancestral characters.

Of the five species which I think should be grouped in the single genus *Zenaida* the North American Mourning Dove, *macroura*, and the South

American Eared Dove, *auriculata*, are sufficiently alike to be considered as members of a single superspecies. The White-winged Dove appears to stand furthest apart both in morphology and in voice and behavior (Whitman, 1919a) but its relationship with the others is quite evident and I agree with Peters that it should not be put in a separate genus.

#### Ectopistes

The question arises as to the generic status of the Passenger Pigeon, *Ectopistes migratorius* (Linnaeus), whose affinity to the Mourning Dove is at once evident when skins or photographs are compared. Salvadori (1893) placed the Mourning Dove in his family Peristeridae and the Passenger Pigeon in Columbidae. His criteria for recognising the former family were, tarsus as long or longer than the middle toe and from twelve to twenty tail feathers instead of always only twelve. Presumably he was influenced in placing the Mourning Dove in Peristeridae by its having fourteen rectrices. On its toe and tarsus proportions it would have qualified for his restricted version of Columbidae. The Passenger Pigeon differs, or rather differed, from *Zenaida* species in its larger size, in lacking the dark facial markings, in its pronounced sexual dimorphism, in laying only one egg to a clutch, in its markedly distinct voice and behaviour (Craig, 1911) and in its ecology (Schorger, 1955). It seems that the sum total of these differences are a good deal greater than those between any of the five species which I suggest should form the genus *Zenaida*, and therefore there is sufficient reason to keep the Passenger Pigeon in a separate genus. At the same time its very close phylogenetic relationship to *Zenaida*, should not be overlooked.

#### Geotrygon, Osculatia, Sturnoenas

It is possible that the American Quail-Doves may be closely related to *Zenaida*. Most of them have facial markings very similar to and apparently homologous with those of *Zenaida*, but they show no such resemblance to *Leptotila* or to the old world genus *Gallicolumba* between which they are usually grouped. Apart from their white-tipped tails the *Leptotila* species do not have any striking or well-defined markings, so their lack of the facial markings common to *Zenaida* and *Geotrygon* may be of little phylogenetic significance. The case is different with *Gallicolumba* species which show very distinctive color-patterns that do not at all resemble those of *Geotrygon*. Affinity between these two genera seems to be indicated only by a striking resemblance in general form and ecology. This may be ascribed to parallel evolution—adaptation to fit similar habitats in the old and new worlds—from more divergent stocks of arboreal pigeons. However, I do not feel confident enough to argue

a case in favor of this conclusion, but only to suggest the possibility.

There seems no valid reason for keeping the Purple Quail-Dove *saphirina*, in the monotypic genus *Osculatia*. Salvadori (1893) recognised this genus on the grounds that the primaries are rather narrow and more or less tapering to a point, the first primary is attenuated at the tip and the tail shorter than half the length of the wing. Of these supposed differences the only real one is the attenuated first primary, for *Geotrygon costaricensis* (Lawrence) and *G. veraguensis* (Lawrence) have the tail shorter than half the length of the wing, and *G. montana* (Linnaeus) and *G. veraguensis* have all their primaries, excepting the outermost one, as narrow and pointed as those of *saphirina*. I do not think this single character of an attenuated first primary warrants generic separation of a species which in every other respect shows its close affinity to others not possessing it. It is proposed, therefore, to unite *Osculatia* with *Geotrygon*.

The Cuban Blue-headed Quail-Dove, *Starnoenas cyanocephala* (Linnaeus), is placed by Peters (1937) between the two monotypic old world genera *Microgoura* and *Otidiphaps* and further separated from *Geotrygon* by the genera *Gallicolumba*, *Leucosarcia* and *Trugon*. In spite of the unusual blue coloration of its head, it seems evident that the affinities of *Starnoenas* are with *Geotrygon* rather than with any old-world genus. The color-pattern of its head is very similar to those of *Geotrygon frenata* and *G. linearis*, and its coloration is not at all unlike these species, except for the blue (instead of bluish grey) on the head and the rather different shade of brown on the upperparts. Its unique features, the hexagonal scales on the front of the tarsi and the black breast patch bordered with white, are, perhaps, sufficient to justify retention of the monotypic genus *Starnoenas*, but certainly do not indicate that it might be more closely related to any oldworld forms than it is to the *Geotrygon* species, to which both its distribution and some of its plumage characters suggest it is most closely allied.

#### SUMMARY

The New World dove species *macroura*, *auriculata*, *aurita*, *asiatica* and *galapagoensis* can be included in the single genus *Zenaida*, thus merging the genera *Zenaidura*, *Melopelia* and *Nesopelia*.

*Osculatia* should be regarded as a synonym of *Geotrygon*, and *Geotrygon* is probably more closely related to *Zenaida* than to the Old World *Gallicolumba*, near which it has been placed. *Starnoenas cyanocephala* is more closely related to *Geotrygon* than it is to any Old World genus.

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FOOD HABITS AND AVAILABLE FOOD OF OVENBIRDS  
IN RELATION TO TERRITORY SIZE

BY JUDITH STENGER

THE greatest controversy among those studying territorial behavior concerns the end for which territories are established by birds (Nice, 1941). A food value theory postulates that the function of territorial behavior is to space out pairs of birds over an area to ensure an adequate supply of food for the successful rearing of the young. This implies that the territory size is related to the amount of food available to the birds within their territories. In this study the relation between territory size and available food was investigated for the Ovenbird (*Seiurus aurocapillus*).

The Ovenbird gathers invertebrate food from the surface of the litter on the forest floor. The feeding ground thus consists of an area, rather than a volume, of the forest. A study of the food habits of the Ovenbird was undertaken by a) examination of stomach contents, and b) sampling of the food items in the places where the Ovenbird normally feeds. Information from these sources was compared to determine whether or not the Ovenbird selected specific items of food. Knowing this, the amount of food available in each territory could be estimated and compared to the size of the territory.

Changes in the amount of invertebrate food present on the forest floor throughout the breeding season of the Ovenbird were determined with a view to learning their relation to the stages of the breeding cycle.

The study was carried out in Algonquin Park, Ontario, at the Wildlife Research Station of the Ontario Department of Lands and Forests during the summers of 1955 and 1956.

## FOOD HABITS

Observations on the Ovenbirds revealed that most of the food was taken from the leaf litter on the forest floor. The food items were picked up with the bill as the birds walked along the ground. Ovenbirds do not scratch in the litter, but may occasionally turn over a leaf with the bill. Some invertebrates were picked up from the low ground vegetation or from the sides of decaying logs. Only once was an Ovenbird observed attempting to feed in a tree; in this activity the bird was extremely awkward. This observation was made during a two-week period at the end of June when the striped maple worm was particularly abundant in maple forests.

Except for some very open areas within the territories of a few of the birds, the areas in which the Ovenbirds fed were evenly dis-

tributed throughout the territory. Where such non-utilized areas occurred within the territories they were subtracted in the consideration of feeding area. Density of brush or ground vegetation had little bearing on the distribution of feeding activity. Thus it was possible to equate the territory with the feeding area.

The more exact food habits of the Ovenbird were determined by examining the contents of 98 stomachs. Forty of these were collected in Algonquin Park during August and September of 1955 in forests similar to the study areas. An additional 24 birds were collected in the same area during June, July and early August of 1956. The remaining 34 stomachs, taken over 11 years, were made available by the Research Division of the Ontario Department of Lands and Forests. Most of these came from various points in central Ontario.

The invertebrates eaten by the Ovenbirds were identified by the author and the numbers of each kind listed. From these numbers and from the average weights of field-collected specimens of the same invertebrate types (calculated on the basis of 12-50 specimens of each) the percentages by weight of each food item in the stomachs was calculated. Percentages were calculated from the combined stomach analysis data, since there was too much variation when such percentages were calculated for each stomach individually. No allowance was made for differential rates of digestion for the different food items.

The stomach analyses (Table 1) indicate that the diet is not the same from year to year, and for this reason the data are given separately for the years 1955 and 1956. Results for the stomachs that were collected over a period of 11 years are combined. Data for the stomachs of five nestlings collected in 1956 are not combined with the data for the adults but are listed separately. The data were analyzed on a seasonal basis also, but it was found that the numbers of stomachs collected each month of the breeding season in each year were too few to show statistically significant differences in the food items eaten during the season.

The food items found in the stomachs can be classified according to their vertical distribution in the forest (Table 2). The category for the surface and subsurface forms includes those which occur exclusively on the ground and therefore represents the minimum food gathered from the forest floor. The value for this category would probably be much higher if forms that occur on the ground only occasionally were included. Also the "widespread" group contains a high proportion of forms that occur on the ground. If it is kept in mind that the forms listed as "surface or subsurface" represent a minimum, it can be seen from Table 2 that most of the food is gathered from the forest floor.

TABLE 1  
STOMACH ANALYSES

Percentage by weight formed by each invertebrate group in the diet

Invertebrate group	11 yrs. adults	1955 adults	1956 adults	1956 nestlings
Otiorhynchinae	19.9%	18.6%	4.4%	
Carabidae	20.7	14.4	11.3	15.4%
Staphylinidae	.6	.5	.3	
Miscellaneous Coleoptera	4.4		7.0	
Unidentified Coleoptera	20.7	11.3	10.6	10.8
Coleoptera larvae	1.6	4.2	1.7	
Lepidoptera larvae	2.9	10.8	32.9	35.4
Diptera larvae		.6	2.0	6.1
Unidentified larvae	24.0	7.5	10.7	17.3
Gasteropoda	2.2	1.6	3.9	12.3
Diplopoda	.9	1.9	1.7	
Chilopoda			.5	
Formicidae	12.3	21.3	4.1	
Miscellaneous Hymenoptera	1.7	1.3	.8	
Diptera	.3	.8	.6	1.5
Hemiptera	1.7	.8	.8	1.5
Araneida	6.1	2.6	4.7	3.1
Lepidoptera and Diptera pupae		1.6	2.0	
Lepidoptera adults				9.2

TABLE 2

PERCENTAGES BY WEIGHT OF THE DIET MADE UP OF INVERTEBRATES GROUPED ACCORDING TO THEIR VERTICAL DISTRIBUTION IN THE FOREST

	11 years	1955	1956
Surface and subsurface forms	83.3%	76.0%	49.5%
Vegetation forms	1.7%	.8%	.8%
Widespread forms	15.0%	23.0%	49.4%

Thus only the forest floor was considered in the study of the amount of food available to the Ovenbird.

Insect larvae, adult Coleoptera, and Gasteropoda are the most important constituents of the nestling diet. The diet does not differ greatly from that of the adults except in the proportion of the larvae, which make up a greater proportion of the nestling diet (Table 1). In 1955 several young birds were collected a few days after they had left the nest and their diet did not differ from that of the adults.

#### LITTER ANALYSIS

During the summer of 1956 two methods were employed to extract invertebrates from samples of litter collected from the forest floor: 1)

Heat-light extraction with a Berlese funnel; 2) Simple screening technique.

The Berlese funnel used in this study was modelled after a funnel used by MacFadyen (1955). When a 150-watt bulb was used as the source of heat and light, those invertebrates that are of the size that the Ovenbird eats come out in about two days. This time limit was adopted for purposes of uniformity. Early in the summer, however, samples were frequently abnormally wet and some were kept in the funnels three to four days. By this method 105 samples were processed.

By the screening technique, the litter samples were shaken through a series of screens and all the invertebrates were collected from the screenings. One hundred and thirty-six samples were processed.

The size of the samples used for both these methods was one square foot of litter from the forest floor. The depth of the samples included the low vegetation covering the square foot and the loose leaves down to the layer where decomposition occurred. The samples were taken at the approximate centre of each 66-foot square (size of grid used in territory study) within the territories in a spot representative of the ground cover of the grid square. "Berlese" and "screening" samples were distributed randomly with respect to each other and approximately equal numbers were extracted by each method for each territory. About 16 to 20 samples were collected from each territory depending on the size of the territory and the uniformity of the structure of the forest.

The two extraction methods were not equally efficient for all the invertebrate groups. The differences in efficiency can be explained by the mechanical procedures involved in the two methods. Stationary forms such as the pupae are not expected to appear in the "Berlese" samples except when they fall through the sieve accidentally. Many Gasteropoda can also probably be considered with the stationary forms because they do not move quickly enough to escape dessication in the funnel.

To determine the composition of the forest floor fauna, results of 105 samples extracted by each method (210 altogether) were combined using the following adjustments. For those invertebrates where there was no significant difference in extraction efficiency, the two totals were added. For the forms that were obtained with the greatest efficiency by the "Berlese" method, the "Berlese" values were doubled except for the winged photo-positive forms (Diptera and Lepidoptera) which may have flown into the aperture of the funnel. For these the "screening" values were doubled. For those that were obtained with the greatest efficiency by the "screening" method, the "screening" values



FIGURE 1. Comparison of percentages of invertebrate groups in the diet with the percentages of the same groups in the litter samples (available on forest floor). Unidentified Coleoptera and unidentified larvae were excluded in the calculation of percentages for the diet.

were doubled (Table 2). The adjustments give an approximate model for the number of invertebrates present in 210 samples. From these numbers the percentage by weight for each invertebrate group is calculated.

#### COMPARISON OF FOOD EATEN AND FOOD AVAILABLE

The invertebrate groups eaten by the Ovenbird (Table 1) were compared with the invertebrates found in the litter samples (Table 3) to determine whether they were eaten in the approximate proportions in which they were available. The Annelida, Phalangida, and adult Lepidoptera were not compared because of their rarity in the stomachs and litter samples; i.e., the sample of stomachs and litter samples was not large enough to compare the weights of these items in them. Only the 1956 data for stomachs and samples are compared since the diet varies slightly from year to year.

All the invertebrate groups found in the stomach analyses were also found in the litter samples from the forest floor. The percentages made up by the various invertebrate food items in the diet and the litter samples cannot be compared directly because the percentage of each item in both the diet and the litter is not independent of the percentages made up by the other items. Certain conclusions can be drawn when the percentages of the invertebrates eaten (those forming more than five per cent of the diet) and the percentages of invertebrates found in the litter are compared graphically (Figure 1).

From Figure 1 it becomes apparent that the major items in both the diet and the litter occur in similar proportions (Carabidae, Otiorhynchinae, miscellaneous Coleoptera, Gasteropoda, Formicidae). Lepidoptera larvae occur in greater proportion in the diet than in the litter, indicating that some larvae may have been gathered from trees, that

TABLE 3

THE NUMBERS,<sup>1</sup> CALCULATED WEIGHTS, AND PERCENTAGES BY WEIGHT (GMS) OF THE TOTAL FOR THE DIFFERENT INVERTEBRATE GROUPS<sup>2</sup> IN 210 LITTER SAMPLES FOR 1956

Invertebrate group	Number	Calculated weight	Percentage of total
Otiorhynchinae	59	.579	2.7
Carabidae	102	2.550	11.8
Staphylinidae	70	.322	1.5
Miscellaneous Coleoptera	114	1.163	5.4
Coleoptera larvae	244	1.854	8.6
Lepidoptera larvae	345	4.589	21.3
Diptera larvae	112	1.467	6.8
Gasteropoda	310	1.798	8.3
Diplopoda	218	1.657	7.7
Chilopoda	390	.858	4.0
Formicidae	620	1.178	5.5
Miscellaneous Hymenoptera	22	.042	.2
Diptera	78	.062	.3
Hemiptera	127	.165	.8
Small Araneida	1142	1.028	4.8
Medium Araneida	183	1.263	5.9
Lepidoptera and Diptera pupae	76	.980	4.5

<sup>1</sup> Numbers adjusted as outlined on pages 338-339.

<sup>2</sup> Only invertebrates eaten by Ovenbirds are included.

there is selectivity for the larvae, or that an increased number of larvae occur on the ground during the short period of greatest abundance. For this period some stomach samples are available, but no litter sampling was done to determine whether the greater number of larvae found in the stomachs could have been obtained from the litter.

Among the remaining groups are some that do not occur in the same proportions in the diet as they do in the litter (Figure 1). These are the Coleoptera and Diptera larvae (miscellaneous larvae), Diplopoda, Chilopoda, Staphylinidae, Lepidoptera and Diptera pupae (miscellaneous groups). These forms all have in common that they are subsurface forms and do not usually come to the top of the litter as do the other forms. Thus they are probably not as available to the Oven-

bird as the litter samples would indicate, since Ovenbirds do not scratch in the litter, although they may occasionally turn over a leaf with the bill.

It can be concluded that in general there is no selectivity for preferable items on the forest floor by the Ovenbirds and that most invertebrate groups are eaten in numbers approximately proportional to their availability.

The diet varies from year to year, as does also the available food. A greater percentage of the diet was made up of Coleoptera in 1955 (Table 1), corresponding to a greater number present in the litter. On the other hand, insect larvae showed up in much higher percentage in the diet in 1956 than in 1955 (Table 1), corresponding to a higher percentage present on the forest floor in 1956. This is further evidence that the food is eaten in the approximate proportions in which it is available to the birds.

#### EXTENT OF TERRITORIES

Territories are established by male Ovenbirds in early May before the arrival of the females. The female takes no part in defense of the territory but restricts her activities within the boundary of the male territory. In his extensive work on this species, Hann (1937) found that the male takes no part in building the nest (time required—five days) or incubating the eggs (about 12 days), but actively participates in feeding the young during the nestling stage (about 8 days). Hann reported that the chicks (usually 5) after leaving the nest become divided between the male and female, the female taking her charges out of the territory permanently, while the male and his chicks remain within the territory until the chicks are independent. Our observations supported these conclusions.

Territories held by 13 males in 1956 and those held by nine males in 1955 were studied in four forest habitats. The total utilized territory, as well as changes in the area utilized daily throughout the breeding season, was investigated. Sight and song observations were plotted on maps of the study areas, which were surveyed into 66 ft. grids. Data from all observation periods were combined and the central 95 per cent of the observation points was enclosed by straight lines to give a total utilized territory for the breeding season. Points for first and second nesting attempts were considered separately. A few of the territories had open, unforested areas within them which were not utilized by the birds and these were subtracted from the polygons outlined by straight lines. Areas utilized daily were obtained by a modification of the observation-area curve method (Odum and Kuenzler, 1955) and will be described in another paper.

Average total utilized territory differed in the four forest habitats in 1956 as follows: mature maple, 3.2 acres (2 males); mixed maple-birch-conifer, 2.4 acres (3 males); pine-birch, 2.2 acres (3 males); aspen, 1.8 acres (3 males). Total utilized territory sizes for individual males are listed in Table 4. Feeding observations were evenly distributed within the total utilized territories. There is usually a buffer zone between the total utilized territories of neighboring birds, although this may not occur between some individuals. Most of the points (five per cent) rejected in the estimation of the total utilized territory occurred in the buffer zone, where there was a noticeable decrease in aggressiveness.

Changes in area utilized daily are as follows. The area utilized was large during the premating period before the females arrived and during a short mating period which preceded nest-building activities. During nest-building and egg-laying periods the area utilized shrank considerably. This was followed by an increase during incubation to a size approximately that utilized during the premating period. Area utilized during the nestling period apparently was as large as during the incubation period, while that utilized after the young left the nest differed for different individuals.

#### INVERTEBRATE FOOD AVAILABLE WITHIN THE TERRITORIES

If territory functions to provide an adequate supply of food for the birds, it might be expected that territory size is inversely proportional to the density of food items within the territory.

To obtain a measure of the amount of food available on the forest floor in each territory, those invertebrate types which also appear in the diet were weighed for each litter sample. There was no significant difference between the average weight of invertebrates per sample obtained by the two extraction methods. Thus the weights obtained by the two extraction methods were considered comparable.

In calculating the weight of invertebrate food per sample for the territories, some of the invertebrates were not included in the weights. Chilopoda and Diplopoda were excluded because only a small proportion of them were eaten, their absence in the diet being explained by their habit of avoiding the surface of the litter. Also excluded are the Annelida, Phalangida, and adult Lepidoptera because, as outlined previously, these forms are rare and the number of litter samples completed was not large enough to give an adequate picture of the role they play in the amount of available food.

The total size of the territories, the forest type in which they occurred, and the average weight of invertebrates per sample in each total

TABLE 4  
SIZE IN ACRES AND THE AVERAGE WEIGHT OF AVAILABLE FOOD PER  
SAMPLE FOR EACH TERRITORY IN 1956

<i>Forest type</i>	<i>Bird</i>	<i>Average Food/sample (gms)</i>	<i>Total territory size (acres)</i>	
			<i>1st nesting</i>	<i>Renesting</i>
Aspen	M28	.106	1.5	1.1
Aspen	M26	.091	1.9	
Aspen	M27	.088	2.1	
Conifer-birch	M24	.074	2.1	
Conifer-birch	M20	.075	2.2	
Conifer-birch	M23	.059	2.2	
Mixed	M32	.066	1.5 <sup>1</sup>	3.4
Mixed	M7	.074	1.8 <sup>2</sup>	
Mixed	M31	.066	2.2	
Mixed	M3	.072	2.4	
Mixed	M5	.060	2.7	3.6
Maple	M30	.072	2.5	
Maple	M29	.043	4.0	

<sup>1</sup> First nesting attempt includes only two days' observation.

<sup>2</sup> Unmated.

territory are listed in Table 4. From Table 4 it can be seen that there is a relation between the available food and the total territory size, which holds within one forest type as well as among the four forest types (aspen, conifer-birch, mixed, maple). Of particular interest are the territories of M30 and M29, both of which were in mature maple forest. These two territories showed the greatest similarity in structural aspect of the forest, and yet showed a very marked difference in the size of the total territory established, as well as the amount of invertebrate food present.

A correlation of .82 is obtained when  $\rho$  is calculated by Spearman's rank method (Snedecor, 1956) for total territory size and the weight of invertebrate food present. These data suggest that the territory established may be directly adjusted in size to the amount of food present.

Other studies in collaboration with Dr. J. B. Falls showed that territory size increased as canopy density increased and as the density of ground vegetation decreased. Abundance of ground vegetation is usually indicative of the amount of humus of a non-acid type. The development of such a humus is dependent on the nature of the leaves which comprise the litter and ultimately on the species comprising the canopy. The development of a deep non-acid humus is conducive to invertebrate abundance and thus these factors are probably all interrelated.

TABLE 5

## AVERAGE WEIGHT OF INVERTEBRATES PER SAMPLE FOR THE MONTHS IN THE BREEDING CYCLE

Month	Average weight per sample (gms)
May 17-31	.074 (14 samples)
June	.074 (31 samples)
July 1-15	.106 (15 samples)
July 16-31	.061 (24 samples)
August 1-10	.066 (20 samples)

The maximum weight of invertebrates occurred during the first half of July (Table 5). This was an increase over the average for May of about 40 per cent. The eggs in most Ovenbird nests hatched on June 26, 27, or 28. Thus the maximum weight of invertebrates occurs at approximately the same time as the nestling period, when the demand for food in the territory is greatest.

## DISCUSSION

The "territory" of the Ovenbird can be represented as an area of utilization which varies in size and shifts slightly from day to day. The combined areas of each daily territory represent the total utilized territory. The area utilized varies from day to day during the breeding season, but appears to have no relation to the number of birds in the family unit obtaining food from it. Thus when the amount of food available is compared to territory size an attempt must be made to interpret the biological meaning of such a relation.

If territory is to ensure an adequate supply of food for the successful rearing of the young, some mechanism must be at work when territories are first established, such that territory will be sufficiently large to supply the extra food required when the eggs hatch since the size of the area utilized does not increase at hatching.

One of Hinde's (1956) arguments against the food value theory is the fact that territories are not defended against other species with similar food requirements. For the Ovenbird, observations showed that the feeding ecology has very little overlap with other species in Algonquin Park. The other common ground-feeding species is the White-throated Sparrow (*Zonotrichia albicollis*), which can be found in the same habitats as the Ovenbird. Aside from the fact that it probably has a very much higher proportion of seeds in the diet, it also differs markedly in its feeding activity from the Ovenbird. Its feeding is much more localized; i.e., it remains in one spot for longer periods of time and scratches to the deeper layers of the litter. Thus the food niche of the

White-throated Sparrow is probably quite different from that of the Ovenbird, and the question of interspecific competition does not arise between the two.

Further, the fact that no expansion of the territory occurs during the nestling stage is probably highly significant. The periods of the breeding cycle are usually well synchronized for all the birds in one area. Thus if an expansion during the nestling period did take place, it would lead to a great deal of struggling among the males of this species when their important duty is to feed the young, since all birds would be trying to expand their territories at the same time.

The behavior of the male, who assists in feeding the young, changes markedly when the eggs hatch. He no longer sings for prolonged periods and the lack of song makes him seem very secretive. The area utilized is as large as during premating and incubation when he is involved in display. Presumably this area is used for the procurement of food for the nestlings.

Usually birds spend more time gathering food during the nestling stage (Palmgren, 1949 from Kuusisto, 1941). In addition to increased time spent by the Ovenbirds in gathering food, there is an increase in the weight of invertebrates on the forest floor from May to July, such that a maximum occurs coincidentally with the nesting period. The increase in the weight of the invertebrates on the forest floor is probably even greater than apparent from the data. During the last two weeks of May, as opposed to the first two weeks of July, the temperature during the night often went down to freezing or below, thus rendering many invertebrates inactive and keeping them below the surface during the early hours of the morning when the birds were engaged in their feeding activities. Thus, during July, when nestlings are being fed, more invertebrates would be active at the surface for a longer period of time each day than during May when the territories are first established. Lack (1950) put forward the view that the breeding season of each species of bird is adjusted by natural selection to that season of the year when the food that the bird is adapted to collecting is sufficiently abundant for it to raise a family. This postulate is borne out by the Ovenbird; but whether this phenomenon is the sole mechanism providing adequate food or whether the territory provides an excess of food throughout the season still requires to be answered.

#### SUMMARY

From examination of stomach contents, the food of the Ovenbird was found to consist chiefly of invertebrates gathered from the forest floor. These invertebrates are not taken selectively but are eaten in the approximate proportions in which they are available.

The weight of invertebrates per litter sample within the territory varied inversely with the size of the total territory established during the breeding season. This correlation held within habitats, as well as among habitats.

The weight of invertebrate food on the forest floor increased during the breeding season to reach a peak during the first two weeks of July, which corresponded with the nestling period of the Ovenbird chicks.

#### ACKNOWLEDGEMENTS

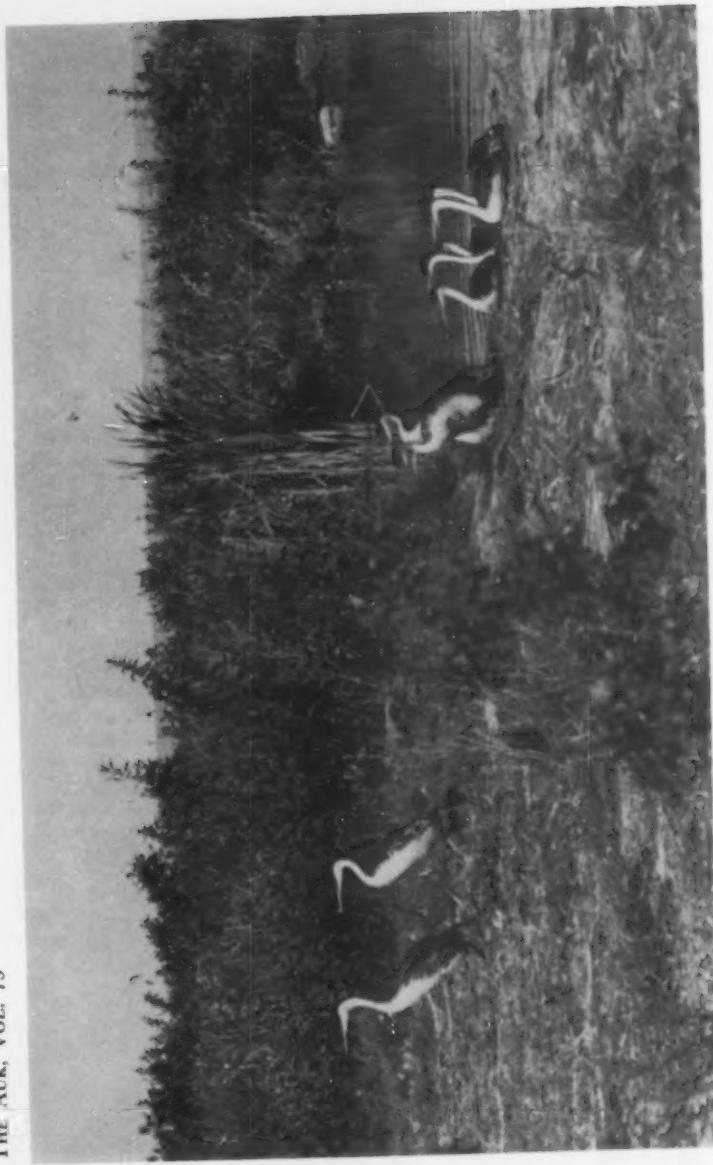
The manuscript is based on part of an M.A. thesis presented at the University of Toronto. The field work was carried out at the Wildlife Research Station of the Ontario Department of Lands and Forests in Algonquin Provincial Park during the summers of 1955 and 1956. The author is very much indebted to Dr. C. D. Fowle and Mr. R. O. Stanfield for so generously making these facilities available. It is a pleasure to acknowledge the constant encouragement and advice of Dr. G. F. Bennett, who suggested the problem, Dr. L. Butler, who made helpful suggestions for the statistical analysis of the data, and Dr. J. B. Falls for reading and discussing the manuscript. The project was supported by funds granted to Dr. J. B. Falls by the National Research Council of Canada and by the Ramsay Wright Scholarship awarded to the author by the University of Toronto.

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WESTERN GREBES ESCAPING OVERLAND FROM A SMALL POND ON ISLE OF BAYS TO  
OLD WIVES LAKE, SASKATCHEWAN, AUGUST 8, 1956. Photo by F. W. Lahman.

## GENERAL NOTES

**Dry-Land Nest-Site of a Western Grebe Colony.**—The Western Grebe (*Aechmophorus occidentalis*) is said invariably to build floating nests located in extensive areas of bullrush (*Scirpus*) or cattails (*Typha*). Recent observations made at Old Wives Lake in southern Saskatchewan show that this species can adapt itself to nesting on dry land.

On August 8, 1956 we travelled to Old Wives Lake, which is located 30 miles southwest of Moose Jaw, and landed on the island known as Isle of Bays. This island is about one and three-quarter miles long and one mile wide and covers about 500 acres. There is a rocky promontory on the south end and sand beaches nearly all the way around the edge.

A great surprise to us was the discovery of a dozen Western Grebes swimming in a small pond (about 60 feet long and 30 feet wide) on the north end of the island, some 30 feet back from the edge of the west beach. We quickly surrounded the pond in order to obtain photographs of the group, some of which escaped overland. It was a strange sight to see these immaculate birds swimming and diving in the dark green, syrupy water of the stagnant pond. A dead brood of ducks floating on the surface of the pond and a dozen or more dead adults nearby—Mallards (*Anas platyrhynchos*), Pintails (*Anas acuta*), and a Black Duck (*Anas rubripes*)—were additional evidence of the stagnant condition. Several Western Grebe nests, some with eggs, in and on the edge of the pond were coated with dried mud, which suggested that the water level had recently been higher. A few cattails on the edge of the pond represented the total "marsh" habitat available.

Young grebes were observed on the backs of two adults that were swimming in the pond, their downy heads and necks protruding from between the wings. When the adults were finally permitted to leave the pond they clambered up on land, momentarily spreading their wings as if for balance, and unexpectedly dropping a few other young which had been concealed beneath their wings. Once underway, the adult birds ran rapidly and on the tips of their toes, in a fairly erect position, without using their wings (Plate 15). Their ability to negotiate the 30-foot stretch of sand astonished all of us.

Previous observations (made chiefly at the London Zoological Gardens) on the walking ability of four species of Old World grebes, and the Western Grebe, have been reported by F. Finn (Journ. Asiatic Soc. Bengal. 66:725-730, 1897). He comments that a Western Grebe was "able to advance only a few steps at a time—waddling along a little way, and then flopping down on its breast." A seemingly greater ability to walk was evinced by other species.

(On October 10, 1956 a Western Grebe found sitting on a lawn in Regina and in apparent good health, but unable to take flight, was released by Lahrman about 30 yards from the shore of a nearby lake on an almost level area covered by short grass. The bird at once headed for the water by pushing along on its belly, kicking with its feet, and bracing its wings against the ground. It repeatedly attempted to stand up but each time immediately fell down. According to Lahrman it showed no evidence of an ability to walk upright. It finally reached the water and then swam rapidly and dove in a normal fashion. It shortly commenced preening. Four Western Grebes captured and released under similar circumstances in previous years behaved in the same manner. However, in the fall of 1957 one grebe stood up and flapping its wings ran all the way to the water.)

About 48 nests were found in and about the pond. An area of some 100 feet by

50 feet to the east of the pond, and separated from it by a heavy stand of rose bushes some two to three feet high and covering an area about 20 feet wide, was also found to be a nesting site (Plate 16). Forty-eight nests contained one to three eggs but a few had one or two more. Approximately 120 nests, most of which still held eggs, were found here. These nests were located as far as 50 feet from the edge of the lake. A six-foot stretch of sand beach was vacant, except at one point where shrubs grew to the edge of the water. One nest in this spot was only three feet from the edge of the lake. Nests were constructed of immediately available materials—grass, in the high areas (Plate 16), and sticks, feathers, etc., in the beach area. All of the nest material had evidently been gathered and placed at the nest-site while in a dry condition. Three nests on the beach contained, in addition to one or more eggs, a number of small stones (Plate 17). This probably represents a habit acquired by the Western Grebe while nesting in the present situation. Stones have been found in the nests of other species nesting in similar habitat, e.g., certain gulls and terns. No young were found in this area; presumably, the large flock of grebes which we observed swimming offshore were carrying any young that they might have had.

A return visit to the island was made on the next day in an attempt to secure movie footage of the grebes running overland. We again made an attempt to surround the grebes on the pond, but this time all except one, which dashed across the beach, escaped by walking and running out along heavily-worn trails among the roses at the east end, travelling some 40 feet to the edge of the water. A very strong west wind seemed to be the deterrent to escaping over the beach. The single bird which did go out this way used its wings while running.

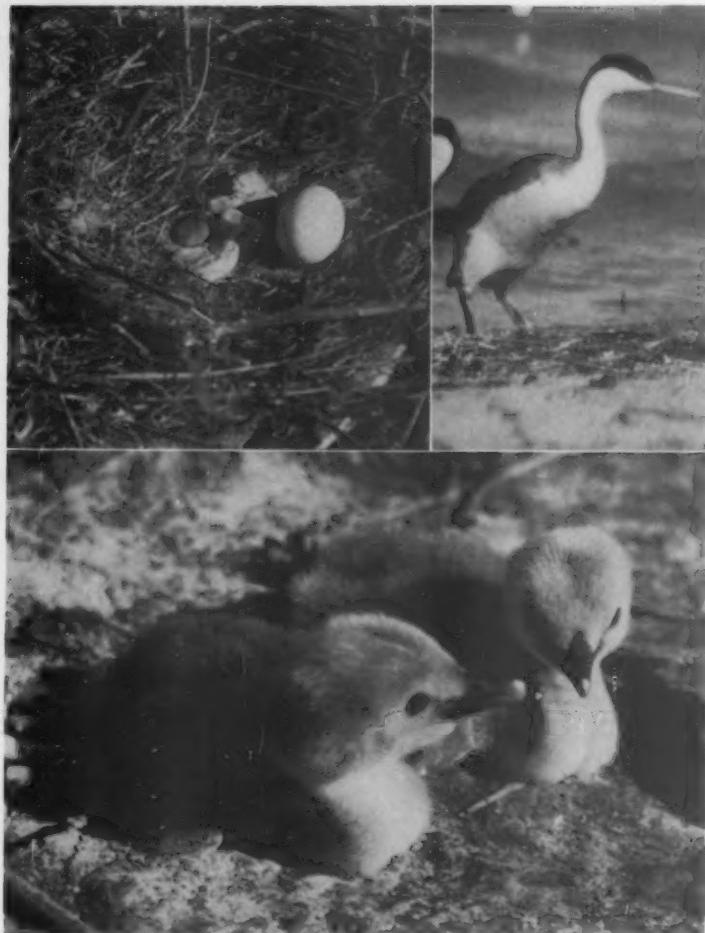
It seems apparent that the Western Grebes in this area have adopted a dry land nesting site as a result of changing conditions. In previous years extensive bullrush beds off the lake shore have harbored large colonies of Western Grebes. As a result of high water during the past few years, this emergent aquatic vegetation has not been available. On June 11, 1953, approximately one thousand pairs of Western Grebes were observed by Bard and Lahrman nesting along the flooded shore of the island at two places. Nests in the vicinity of the location described in this report were at that time anchored in clumps of small rose and willow bushes which were standing in shallow water. Windrows of waterweeds, lodged among the bushes, shut off pools which were favored by the grebes. In succeeding years the water level rose even higher and these bushes eventually disappeared.

In July, 1953, according to R. A. McCabe (pers. comm.), he and W. Leitch found 64 active grebe nests in shallow water and inland on the island, evidently in the same locality.

We visited the island again in 1957 and found grebes nesting under similar conditions. On June 6 we found approximately 250 nests located in about the same area but mainly beneath the extensive clumps of rose bushes. These nests each held from one to five eggs. Again, nests consisted of only a small amount of material, chiefly dry grass, twigs and feathers evidently gathered in the vicinity of the nest. Nests were found in four groups, three on the north shore and a fourth, the largest group with more than 100 nests, on the west shore about 100 feet from the others. The grass near the nests was heavily trampled, giving evidence of considerable activity. Nesting Common Terns (*Sterna hirundo*) completely surrounded one group; the others were bordered by Ring-billed Gulls (*Larus delawarensis*). Nests of both terns and gulls were found within two feet



DRY LAND COLONY OF WESTERN GREBES AT OLD WIVES LAKE, SASKATCHEWAN,  
AUGUST 8, 1956. *Above:* DRY LAND NEST-SITE. *Below:* DRY LAND NESTS. *Photos  
by F. W. Lahrman.*



WESTERN GREBE AT OLD WIVES LAKE, SASKATCHEWAN. *Left Above:* GREBE NEST NEAR BEACH CONTAINING SEVERAL STONES AND ONE EGG.  
*Right Above:* WESTERN GREBE STANDING ON EDGE OF BEACH—JUNE, 1957.  
*Below:* DOWNTY YOUNG WESTERN GREBES—AUGUST 8, 1956. Photos by F. W. Lahrman.

of grebe nests and some gull nests were actually located between grebe nests. Nearly all of the grebe nests were more than 18 feet from the edge of the water; several were 75 feet away. No young were seen on this date. After some time we retired to a considerable distance and later watched the grebes return to their nests. We found that they walked readily, even standing erect momentarily (Plate 17). Throughout the day they frequently left the nest without apparent provocation, standing up and slowly walking across the bare sand and gravel beach.

Although the grebes had adapted to a dry-land nesting-site, they were nesting under some difficulty. Frequently, when they walked across the beach they were struck down by Common Terns, and at every uprising of the gull colony—and this occurred often—the grebes left their nests. They suffered in other respects too, the feet of captured grebes being dry, cracked and scaly, presumably as a result of continued exposure to the hot dry air and from walking across the sand and gravel beach.

Return visits to the island for purposes of a behavior study of this species were made on June 13-June 22, June 26-July 4, and July 19-July 20. Nesting occurred throughout June but by July 19 had ceased except for desultory breeding behavior. Only a few young were observed during this period (one or two only on June 13 and June 19) and it is believed that nesting success was extremely low. It seems questionable whether this grebe colony can long survive under this condition, but there are indications of a regrowth of natural aquatic vegetation and in the future they may return to nesting in more normal habitat.—ROBERT W. NERO, FRED W. LAHRMAN, AND FRED G. BARD, Saskatchewan Museum of Natural History, Regina, Saskatchewan.

**The Lesser Black-backed Gull in the New York City Area.**—A Lesser Black-backed Gull of the British race, *Larus fuscus graellsii*, was collected by the author on a garbage dump near Rutherford, New Jersey, on Feb. 9, 1958. The bird (AMNH #468815), an adult female in winter plumage, weighed 825 gms. and measured: exposed culmen 49 mm, wing (flat) 410 mm, tarsus 53 mm, tail 56 mm, and ovary 15 x 6 mm; the orbital ring was bright red-orange, and the legs were yellow. The subspecific identification of the specimen was confirmed by Eugene Eisenmann. This is the first specimen of this species for New Jersey and the third for North America, the previous specimens, also identified as *graellsii*, being taken at Assateague Is., Maryland, Oct. 7, 1948 by J. H. Buckalew (*Auk*, 67: 251, 1950), and at Buffalo, New York, March 14, 1949 by R. F. Andrie (Buffalo Society of Natural Sciences #4084).

Sight reports of the Lesser Black-back, first noted in the United States at Beach Haven, New Jersey by C. A. Urner and J. L. Edwards on September 9, 1934 (*Auk*, 52: 85, 1935), have become more frequent in the New York City region in recent years (Cruickshank, "Birds Around New York City," p. 225, 1942), with several sight reports each winter, and one as late as March 29, 1945 (Alexander, *Auk*, 63: 258, 1946). Most reports of the bird have been at garbage dumps or near sewer outlets, in association with Herring Gulls (*Larus argentatus*). Both currently recognized subspecies of the Lesser Black-backed Gull (*fuscus* and *graellsii*) have been reported on the basis of sight observations, but subspecific field identifications cannot be considered reliable because light conditions may alter the apparent shade of the mantle. In fact, as Griscom (*Bull. Mass. Aud. Soc.*, 28: 181-191, 1944) points out, even sight records of the species are open to considerable question due to the possibility of confusion with other dark-backed gulls. However, the prob-

ability that most sight reports of *L. fuscus* in the eastern United States are correct as to species and are referable to *graellsii* is enhanced by the fact that this form migrates along the Atlantic coast of Europe and that New World sight records are from the Atlantic watershed at latitudes frequented on the usual Old World wintering grounds.—JOSEPH R. JEHL, JR., 385 Grove Street, Clifton, New Jersey.

**A Possible United States Breeding Area for the Violet-crowned Hummingbird.**—On a field trip to the Guadalupe Mountains of southeastern Arizona and adjacent New Mexico, July 23 to 25, 1957, my brother John and I identified as many as six Violet-crowned Hummingbirds (*Amazilia verticalis*), and one was collected. This Mexican species is reported as "casual" in the United States (A.O.U. Check-list, 5th ed.: 306, 1957). The only previously known United States specimens are: one from Palmerlee, Huachuca Mountains, Arizona, July 4, 1905 (Bishop, Auk 23: 337, 1906); another taken by H. H. Kimball near Paradise, Chiricahua Mountains, Arizona, July 16, 1925 (Journ. Wash. Acad. Sci. 37 (3): 103-104, 1947); and an adult female collected by A. R. Phillips near Patagonia, Santa Cruz Co., Arizona on August 20, 1948 (personal letter).

Our first bird was seen on the 24th about a mile above the Johnson Ranch in Guadalupe Canyon, New Mexico. It pugnaciously chased from the area a male Broad-billed Hummingbird (*Cynanthus latirostris*). After the chase we could not locate it again. Later the same day we saw another Violet-crowned Hummingbird in this canyon about 2 miles into Arizona from the state-line. It acted in the same manner as the first bird, except that it landed in a dead tree directly in front of us, so close that I could not shoot for fear of completely destroying it. We had an excellent study before it flew. All salient characters, including the clear white underparts, violet crown, and green back and tail, were carefully noted.

On the 25th we returned to the Arizona site. After waiting some time with no result, we went about a mile further up the canyon, where a Violet-crowned Hummingbird streaked over us heading for a blooming agave. The bird seemed nervous, and, as we approached, it darted into a grove of large sycamores. A Violet-crowned Hummingbird along with several Broad-billed Hummingbirds and Black-chinned Hummingbirds (*Archilochus alexandri*) were observed feeding at the agave. The Violet-crowned Hummingbird always appeared and left in the same direction. It came to the agave to feed every five to ten minutes. The bird acted in a manner suggesting that it was feeding young. When finally collected the bird proved to be a fine adult female with slightly enlarged ovaries and evidence of a recent brood patch. On the way back to our truck, a distance of two miles, we located three other individuals of this species. A violent rainstorm, the worst in many years, prevented further field work.

The greenish tail and the white wing edge of our bird agrees with Wetmore's (Jour. Wash. Acad. Sci. 37(3): 103-104, 1947) description of *elliotti*, and Eugene Eisenmann of the American Museum of Natural History has examined the specimen and confirms the racial identification. This bird is now in the Fish and Wildlife Service collection at the U. S. National Museum.—SEYMOUR H. LEVY, Route 9, Box 960, Tucson, Arizona.

**Function of Cryptic White in the White-necked Raven.**—Courtship and hostile displays of birds frequently involve the use of contrasting colors and bold patterns. Common species in the United States that use black-and-white patterns in display include the Inca Dove (*Scardafella inca*), Mockingbird (*Mimus poly-*

glottos) and Phainopepla (*Phainopepla nitens*). The cryptic white on the White-necked Raven (*Corvus cryptoleucus*) has not been shown to have a function in the behavior of the species, but it is unlikely that the white is in fact without meaning. The observations below indicate a hostile (more precisely, agonistic) function of the concealed white.

A first-year male White-necked Raven, after having been held captive for about one month while a broken wing was healing, was introduced into an outdoor aviary in Mesilla, New Mexico, in September 1957; there it met five other White-necked Ravens, which had been wing-clipped captives for one to two years. This group of birds had established a working social organization and the introduction of the new bird seemingly disturbed this order. There ensued forceful exhibitions of aggression, both on the part of the original five birds and the newcomer. The typical display of hostility involved a bird assuming a horizontal posture with the neck moderately extended, and with the feathers of the head and neck fully erected. With the feathers so erected a vast area of black-tipped white was exposed; this white area was made clearly evident to an antagonist as the displaying bird posed obliquely to the immediate front of the antagonist. The posture was accompanied by an intermittent, aggressive, low-pitched *caw*.

The dominant member of the original group was the most aggressive bird. However, after this bird had established dominance (over the newcomer) it did not display the cryptic white to the same extent as it had done previously; its associates maintained a full display of the white whenever the newcomer approached them. The newcomer was continually in a state of hostile display and remained so throughout the course of observation. There were a few minor skirmishes and the newcomer was once jostled off its perch while thus engaged.

In the situations just described the display of the cryptic white occurred only in aggressive and defensive behavior. Thus, the white, in conjunction with the horizontal threat posture, may serve as a signal of aggressiveness, and even of willingness to engage in physical contact, as long as an agonistic relationship remains equivocal.

In spring in 1956 and in 1957 I observed wild White-necked Ravens on numerous occasions (they are abundant in the Mesilla Valley). At no time did I see the cryptic white used in a courtship situation. Blake (*Auk*, 74: 95-96, 1957) has postulated such epigamic function of the concealed white, but I was unable to find support for this.—RICHARD F. JOHNSTON, *Museum of Natural History, University of Kansas, Lawrence, March 17, 1958.*

**Nest of Mockingbird in Pile of Fence Rails.**—On May 20, 1954, a farmer friend showed me an unusual nest of a pair of Mockingbirds (*Mimus polyglottos polyglottos*) near Lexington, Virginia. It was situated in a pile of fence rails in the open and contained three half-grown young. The nest was placed among the ends of the rails, three feet from the ground, and entirely exposed. A thick cedar bush some twenty feet away would have offered a much more normal site. The nest was unusually wide and bulky, made of the usual sticks and rootlets, with some sheep's wool. Alexander Sprunt, in his comprehensive article on the Eastern Mockingbird in Bent (*U. S. Natl. Mus. Bull.*, 195: 295-314, 1948), does not list any such location, although in the same volume (p. 318) the western race (*M. p. leucopterus*) is reported to build in brush piles and in the corners of rail fences in Texas.—J. J. MURRAY, 6 White Street, Lexington, Virginia.

**A Snake-eating Robin.**—On February 6, 1958, while staying at the Archbold Biological Station, Lake Placid, Florida, I frightened a Robin (*Turdus migratorius*) from an open place in pine woods and near a swamp. The Robin flew to the edge of a thicket of saw palmetto (*Serenoa*) with something hanging from its bill. I now saw that it was trying to swallow a small snake, 8 to 10 inches of which hung from a corner of its mouth. A little later the Robin flew 15 or 20 yards to open ground. Here it assumed a peculiar stance with head forward and body vertical, as if leaning back on its tail. By this time and for the remainder of the 18 minutes I had the bird under observation, it made no real efforts to swallow or to disgorge the snake but just let it dangle. It flew to several other places. Its final perch was on a limb in full sunshine where I took its picture through a telephoto lens. After that I lost track of the robin in a thicket. The snake, pale yellowish underneath and dark on top with a thin yellow stripe, corresponded to pictures of the Ribbon Snake (*Thamnophis sauritus*). Exact identification, however, could not be made. I have found no similar instance reported by Bent (U. S. Nat. Mus. Bull., 196: 14-6, 1949), though he mentions the case of a robin eating a dead field mouse, possibly killed by a terrier (*op. cit.*: 50-51).—LAWRENCE KILHAM, 7815 Aberdeen Road, Bethesda, Maryland.

**A Connecticut Breeding Record for the Blue-gray Gnatcatcher.**—The author with Hans Weber observed on territory a pair of Blue-gray Gnatcatchers (*Poliopitila caerulea*) during June, 1957 near the Mansfield Hollow Dam in Mansfield, Connecticut. We were able to establish what appears to be the first Connecticut breeding record for this species, which has been observed with increasing frequency in the state in recent years. A pair did build a nest in southwestern Connecticut in May, 1947 but were not successful (see Auk, 67: 255, 1950). The A. O. U. Checklist (1957) does not list it as a breeder northeast of New Jersey and New York.

The dam basin consists of rather well drained marshland and storage areas, unusually dry in June, 1957. The surrounding areas are partly oak and pine forest and partly old fields growing into scrub woods. The pair was first observed on June 10, 1957 in a large white pine on the edge of the basin. They flew frequently between the pine and a nearby thicket although apparently were carrying neither food nor nesting material on that date. A Blue Jay (*Cyanocitta cristata*) which flew into the pine was viciously attacked by the gnatcatchers until he withdrew. A House Wren (*Troglodytes aedon*) singing from the tree top was not molested.

Repeated observations of the birds were made by members of the Natchaug Ornithological Society. The birds were usually to be found in the pine or in the nearby thicket. Although the nest was not located, the author and many members of the Society (including Jerault A. Manter and James A. Slater, respectively Professor Emeritus and Professor of Ornithology in the University of Connecticut) on June 28 observed four young being fed by adults in oaks on a nearby ridge. The young on June 28 were barely able to fly and could not have been more than a day or two out of the nest. Neither the adults nor young were subsequently observed.—ROBERT W. LOUCER, University of Connecticut, Storrs, Connecticut.

**The Affinities of *Oreothraupis arremonops*.**—One of the unsolved problems in the classification of the passerine birds is the delimiting of the tanagers and the groups to which they are closely allied. Until much more is known about the behavior and anatomy of many species, the final answer cannot be expected. Still, it is possible on the basis of "skin" characters to point out certain apparent rela-

ships. A case in point is the systematic position of *Oreothraupis arremonops*. This bird, called the Finch-like Tanager by Hellmayr (Cat. Birds Americas, Field Mus. Nat. Hist., Zool. Ser. 13, part 9, 1936), is known only from the subtropical zone of western Colombia and Ecuador. Birds of both sexes are predominantly rust-color, the belly and under tail coverts being white and the crown striped with black and gray. The large feet and strong legs indicate that these birds are at least in part terrestrial.

The species was described as *Saltator arremonops* by Sclater (Proc. Zool. Soc. London, 23: 84-85, 1855), who at the time stated that the bill was "altogether abnormal, the upper mandible swelling in the middle and overlapping the under, as in the genus *Lanius*, though not developed into a decided hook." The following year, Sclater (Proc. Zool. Soc. London, 24: 80, 1856) set up the monotypic genus *Oreothraupis* for this species, using the bill character as the basis for the generic diagnosis and placing the genus between *Cissopis* and *Arremon*. In 1886 (Cat. Birds Brit. Mus., 11: 298), Sclater placed *Oreothraupis* in the "Pitylinae tumidirostres" with the genera *Cissopis*, *Schistochlamys*, and *Pitylus*. In 1912, von Berlepsch (Verh. 5th Internat. Ornith. Kongr., Berlin, p. 1104-1105) placed *Oreothraupis* between the genera *Lysurus* and *Arremon*. Ridgway (U. S. Natl. Mus. Bull. 50, pt. 1, p. 24, 1901) removed several genera, including *Pezopetes*, *Buarremón*, *Arremon*, *Saltator*, and *Pitylus* from the tanagers and placed them in the Fringillidae. Among these transferred genera he listed *Oreothraupis* with a query, but he made no further comment, presumably because the genus did not occur within the region covered by the work. Hellmayr (*op. cit.*) for the most part followed Sclater's 1886 arrangement but omitted the genera which Ridgway removed to the Fringillidae. He retained *Oreothraupis* in the Thraupidae but stated in a footnote (p. 437) that "the systematic position of this remarkable bird can only be determined by the study of its anatomy. It may prove to be of Fringilline affinities."

After examining six skins of this species at the American Museum of Natural History and U. S. National Museum, I am convinced that *Oreothraupis arremonops* is closely related to the members of the "finch" genus *Atlapetes* which were formerly separated as the genus *Buarremón*. Points of resemblance are the pattern and texture of the plumage, particularly the black and gray striped crown; the broad, lax, somewhat pointed rectrices; the stout legs and feet; and the short, rounded wings. One female in the collections of the American Museum has retained part of the juvenal plumage on the throat and under tail coverts. These juvenal feathers are sooty in color like those of some species of "*Buarremón*." The rusty color of much of the adult plumage of *Oreothraupis arremonops* is suggested by the orange tinge of the green plumage of *Atlapetes* (*Buarremón*) *torquatus basilicus*. Finally, bill form in the genus *Atlapetes* is quite variable, and the bill of *Oreothraupis* falls within the range of variation of that genus, except for its greater breadth, more curved culmen, and the slightly greater swelling of the upper mandible first described by Sclater.

Nowhere in the literature have I been able to find a critical discussion of the relationships of *Oreothraupis*. In most instances an author's beliefs regarding the affinities of this genus must be inferred from his linear arrangement of it and the genera placed near it. *Oreothraupis* was described and placed in the tanagers at a time when the emberizine genera *Arremon*, *Buarremón*, *Lysurus*, and *Pesopetes* were considered tanagers. That *Oreothraupis* was kept in the Thraupidae after these other genera were removed was very likely a result of Sclater's having used

the root "thraupis" in the generic name. It must be admitted that a taxonomist can (albeit unconsciously) be influenced in his thinking on the matter of relationships by a bird's name, either vernacular or scientific.

In spite of Hellmayr's comment that the systematic position of *Oreothraupis* can only be determined by a study of its anatomy, I believe that evidence from the study of skins alone is strong enough to warrant its removal from the tanagers and its transfer to a position near (or possibly in) the genus *Atlapetes*.—ROBERT W. STORER, University of Michigan Museum of Zoology, Ann Arbor, Michigan.

**Recent Additions to the Avifauna of Alabama.**—Field work in Alabama has increased considerably in recent years, with the result that observers have collected species new to the state or first specimens of others that occur rather regularly. These records modify the A. O. U. Check-list (1957) status of the species concerned or provide specimen confirmation of sight records accepted by the Check-list. Except for the records of the White-faced Ibis at Marion, the Mottled Duck in May, 1955, the Scissor-tailed Flycatcher at Livingston, and the White-fronted Goose at Coden, all records since 1947 herein cited have been noted very briefly in *Audubon Field Notes* (Central Southern Region) for the appropriate season (1-12, Nos. 1, 2, 3, 4, and 5, 1947-1958). The present paper coordinates these records by species, rather than chronologically, and gives additional details. The following initials refer to collections where specimens are housed: DC—Alabama Department of Conservation, FSU—Florida State University, LSU—Louisiana State University, UA—University of Alabama, USNM—United States National Museum.

1. *Bubulcus ibis*, Cattle Egret.—The only record is that of a specimen without any fat at all (UA) collected by James E. Keeler on Cochrane Causeway near Mobile, November 8, 1957.

2. *Dichromonassa rufescens*, Reddish Egret.—The first record was that of five birds seen on Dauphin Island, July 23, 1955. The observer, Ralph L. Chermock, collected one (UA). This species has since proved to be a regular transient on Dauphin Island in small numbers (most seen, 5, July 23, 1955, and October 6, 1956); extremes, March 17 (Chermock) to April 21 (Imhof) and July 23 (Chermock) to October 20 (Dusi and others). Also one bird was seen on a farm pond 25 miles south of Montgomery, August 13, 1955 (L. E. Goodnight), and another at Gulf Shores, October 6, 1956 (Francis M. Weston and Goodnight). Additional specimens were collected September 23, 1955 (UA) and October 7, 1956 (FSU).

3. *Plegadis chihi*, White-faced Ibis.—On May 30, 1956, Burt L. Monroe, Jr. found a freshly-killed specimen (LSU) at Gulf Shores. The specimen, a second-year bird, was identified by Newman, Lowery, and Belknap. Imhof and Lois McCollough found another specimen (UA, *chihi*, *fide* John W. Aldrich) on Dauphin Island, October 5, 1956. It was blind in one eye and had been run over by a car. At least a dozen additional sight records of *Plegadis* (most seen, 5, Petit Bois Island, June 17, 1956, Imhof and others) are for the period April 29 (1952, Furman, Wilcox Co., Keeler) to November 6 (1948, Gulf Shores, Weston and M. Wilson Gaillard). Except for one at Marion in the summer of 1956 (R. Snow), none of the observers saw white behind the eye; nevertheless, bearing in mind the geographic position of Alabama, the specific identity of these dark-faced birds must remain in doubt.

4. *Dendrocygna bicolor*, Fulvous Tree Duck.—The only record is that of a

specimen (DC) obtained from a hunter by Roy Gaisser at Chuckfee Bay, ten miles north of Mobile on November 7, 1956.

5. *Anas fulvigula*, Mottled Duck—The only specimen (UA) was collected from a small *Salicornia* marsh at the western end of Dauphin Island, September 23, 1955, by W. W. Beshears, Jr. and Imhof. Six additional sight records are: May, 1955, west point of Dauphin Island (Eugene Collier); Grand Bay, Mobile Co., October 11, 1941, and July 12, 1944 (J. L. Dorn); West Fowl River, June 16, 1956 (O. L. Austin, Jr., and others); Cochrane Causeway, December 3, 1939, and December 29, 1954 (Dorn, AFN, 9:160). Many other probable records are mostly in summer on the outer islands and peninsulas, sometimes with young. Some are listed in Howell (Birds of Alabama, 1928:48). These suggest that this species probably breeds along the coast in small numbers.

6. *Anas cyanoptera*, Cinnamon Teal—The sole record is that of a male specimen (UA) obtained by Walter B. Jones at Chuckfee Bay during the period November 7-9, 1956.

7. *Tryngites subruficollis*, Buff-breasted Sandpiper—The only specimen is one (USNM) collected by Ernest Byford from a flock of 5, probably 14 others, located and identified by Eugene Cypert and others at Garth Slough, Wheeler Refuge, September 14, 1955. Two were still present on September 23 (Atkeson, *Wilson Bull.*, 68: 326-327). Five additional sight records are: Stroud, Chambers Co., August 10, 1952 (Henry M. Stevenson); Tuscaloosa, September 7, 1938 (Stevenson); Northport, Tuscaloosa Co., September 24, 1938 (Stevenson); Gulf Shores, September 12, 1955 (Julian and Rosemary Dusi); and Spring Hill College Golf Course, September 26, 1941 (Dorn).

8. *Himantopus mexicanus*, Black-necked Stilt—A bird seen on Dauphin Island, October 6, 1956 (Stephen M. Russell and Edwin O. Willis), was collected the next day (FSU) by Lovett E. Williams. The only other record is that of one at Romeo Beach near Gulf Shores, August 9, 1953 (Stevenson).

9. *Tyrannus dominicensis*, Gray Kingbird—One of a group of four seen on Dauphin Island, August 24, 1956, was collected (UA) by Stevenson. Except for two Louisiana records, this is the westernmost record of the species. It has bred at Fort Morgan since 1950 when Stevenson saw a pair building on May 14 (Stevenson, Auk, 68: 510-511). C. W. Sumnerour saw dependent young on July 4, 1952, and Dorn also saw young in June or July, 1954. Extreme dates at Fort Morgan are: May 1 (1954, Imhof and many others) and September 25 (1957, Keeler).

10. *Muscivora forficata*, Scissor-tailed Flycatcher—Imhof and McCollough collected an immature (UA) on Dauphin Island, October 5, 1956, and another was seen there October 7, 1956 (Russell and Willis). Two other coastal records are for Fort Morgan, 5 miles east of Dauphin Island, December 27, 1954 (Austin), and April 21, 1956 (Monroe, Weston, and Williams). Inland there are three spring records: Autaugaville, May, 1889 or 1890, specimen not preserved (Lewis S. Golsan, Howell, *op. cit.*: 185); Livingston, Sumter Co., April 24, 1953 (Amy Mason); and Cullman, June 2, 1957 (David Brown, *fide* B. B. Coffey, Jr.).

11. *Anthus spragueii*, Sprague's Pipit—Two records for Birmingham, April 15, 1958 and October 17, 1956, both by Imhof, on an abandoned airfield. The October bird is the only Alabama specimen (UA). Edith L. Clark recorded the species at the Gadsden Airport on February 26, 1956 (eight birds), and on September 29, 1956 (one). The only other record is that of one at Foley, Baldwin Co., April 13, 1957 (Stevenson).

12. *Dendroica nigrescens*, Black-throated Gray Warbler—On October 7, 1956, on Little Dauphin Island, Robert T. Lynn identified one which was seen by many others and collected later that day (FSU). A male seen in a cedar on Dauphin Island, October 18, 1957 by Imhof, Gaillard, and Harriett H. Wright, is the only other record.

13. *Sturnella neglecta*, Western Meadowlark—Prior to January, 1957, the only record was that of a singing bird at Fort Morgan, March 19, 1949 (Stevenson, Auk, 67: 396). Between January 11 and March 15, 1957, and between November 29, 1957 and March 23, 1958, birds were seen in at least 8 localities with a maximum of 20 at Marion (McCollough and Imhof). Specimens (UA) were collected at Marion, February 16, 1957 (Imhof and McCollough) and near Hartselle, Morgan Co., March 4, 1957 (Monroe). Sight records are from Limestone, Jackson, Perry, Baldwin, and Mobile Counties by numerous observers.

14. *Melospiza lincolni*, Lincoln's Sparrow—On November 3, 1956, in Birmingham, Imhof and others mist-netted three of these skulkers and preserved one (UA). Howell made the first sight record at Florence, May 4, 1912 (Howell, *op. cit.*: 246). Over two dozen other records are for the period April 11 (1937, Birmingham, Stevenson) to May 25 (1941, Florence, Stevenson); October 19, 1957 (Dauphin Island, Imhof); and at Marion up to ten birds between February 8 and March 15, 1957, and two from December 27, 1957 through January, 1958 (McCollough).

15. *Calcarius lapponicus*, Lapland Longspur—From a flock of 22 at the Gadsden Municipal Airport, Imhof collected two (UA) on January 21, 1956. This species was first recorded from Alabama when Imhof saw flocks throughout January, 1944 at the same locality. It has been noted every winter since 1949-1950 in at least 6 localities south to Marion, Prattville, and Montgomery during the period December 1 (1956, Marion, McCollough) to February 16 (1957, Marion, McCollough) with a maximum of 80 birds on January 26, 1957 at Marion.

16. *Calcarius pictus*, Smith's Longspur—Imhof and Idalene F. Snead collected one (UA) at Birmingham on January 17, 1956. Of the two other records, both in flocks of *C. lapponicus*, one is that of two birds seen on the same field on December 5, 1955 (Imhof, Snead, and Brownlie), and the other of one bird at Marion, December 27, 1957 (Imhof and Dan C. Holliman).

For the presence of the following species of recent occurrence in Alabama, we have evidence less than a *preserved* specimen, but better than a sight record.

1. *Olor columbianus*, Whistling Swan—Seven sight records between November 3 (1957, Wheeler Refuge, M. H. Parker) and March 25 (1950, Wheeler Refuge, Clarence Cottam) are mostly at Wheeler Refuge. One is of a bird there November 16 and 17, 1942, which is supported by a 16 mm. color film taken with a telephoto lens by Chester R. Markley. Several attempts to see this film have failed.

2. *Anser albifrons*, White-fronted Goose—In addition to a flock of 27 seen at Wheeler Refuge for several days in March, 1942 under the best of conditions by expert observers (Atkeson and others), an adult specimen was taken but not preserved in November, 1953, at Coden, Mobile Co. by Eugene Collier.

3. *Chen hyperborea*, Snow Goose—This bird is uncommon to common in fall in western Alabama, and common in winter at Wheeler Refuge where up to 50 birds have been recorded in winter, extremes there, October 2 and April 28 (Atkeson and many others). Numerous birds have been shot by hunters and examined in game bags by competent conservation agents. Local ornithologists have even shot and eaten them, unaware that no preserved specimen for Alabama exists.

4. *Melanitta deglandi*, White-winged Scoter—Of three Tennessee Valley records, one is that of a bird found in a hunter's bag on December 2, 1942, by Paul Bryan and John H. Steenis. Three additional records are for the Gulf Coast. For the six state records, extremes are November 2 (1954, Wheeler Refuge, Hulse) and April 13 (1957, 3 birds, Gulf Shores, Weston, Monroe, and Goodnight); most seen, 15, November 29, 1957 (Fort Morgan, Monroe and Stevenson).

5. *Oidemia nigra*, Common Scoter—Three immature or female specimens were seen in hunters' bags on Upper Mobile Bay in November and December, 1948 by Francis X. Leuth and Claude Oberhaus. Two additional sight records are for Mobile Co.: Coffee Island, 4 birds with Surf Scoters, April 13, 1957 (Imhof, Gaillard, and Bosarge), and Cedar Point, a flock of 8, December 21, 1957 (Imhof).

6. *Ictinea mississippiensis*, Mississippi Kite—A locally uncommon summer resident, this species is known to have bred at Spring Hill College near Mobile in 1949 (Dorn), and was seen carrying food (grasshoppers) at Magnolia Springs, Baldwin Co., on July 22, 1952 (Summerour). It has occurred at nine other south Alabama localities in the last ten years: extremes—March 26 (1922, Booth, Antaugua Co., Golsan) and August 19 (1936, Bellamy, Sumter Co., H. S. Peters and Giles), and also three times north of the Fall Line in spring. P. H. Gosse, about August 1, 1859, obtained a specimen but did not preserve it (P. H. Gosse, Letters from Alabama, 1859: 217-218).

7. *Buteo swainsoni*, Swainson's Hawk—A bird (44-612304) banded by B. W. Cartwright as a nestling at Roussay Lakes, Yorkton, Saskatchewan, July 6, 1946, was shot but not preserved on a farm near Selma about November 10, 1946. This is the only record for the state.

8. *Grus canadensis*, Sandhill Crane—No Alabama specimen is known, and Federal law forbids the taking of one (photographers, please note). "An adult and a young bird were captured near the mouth of Perdido Bay" in the summer of 1911, (Howell, *op. cit.*: 85). The species was last recorded in summer to my knowledge in 1936 (near mouth of Perdido Bay, H. S. Peters and others), however, it still winters annually, extremes at Elberta, Nov. 30, 1947 (Weston and others) and March 20, 1958 (F. C. Seibert), with at least 20 present in 1957-58 (R. W. Skinner and others). Local residents who know the birds well, and are the only people in Alabama who do not call herons "cranes," say that 25 were present early in 1955.

9. *Oporornis philadelphia*, Mourning Warbler—On October 7, 1954, David C. Hulse picked up a badly-smashed specimen on the road near Decatur. It was not preserved. Three other sight records are for the northern part of the state in late May (Imhof, Stevenson, and Willis).

10. *Loxia curvirostra*, Red Crossbill—In Autaugaville about 1883, several were shot for identification purposes out of a flock of 25 to 30 (Golsan and Holt, Auk, 31: 227). In Gadsden, a maximum of 17 have visited the mountain-top feeding station of Edith Clark daily from December, 1955 to July, 1956, and from August to December, 1957. In March, 1956, Mrs. Clark saw a pair carrying nesting material toward a roadless area. Except for a flock of 8-15 seen on several occasions in Montgomery in January, 1950 (Summerour), the few other sight records are for the northeastern counties.—THOMAS A. IMHOF, 307 38th Street, Fairfield, Alabama.

**Records of Eastern Birds from the Chiricahua Mountains of Arizona.**—During the latter half of 1956 at the Southwestern Research Station of the American Museum of Natural History, in Cave Creek Canyon, Chiricahua Mountains, south-

eastern Arizona, a number of eastern birds were recorded which, according to the A. O. U. Check-list (1957), are unknown from, or accidental in, the area. The birds presumably arrived in the vicinity of the Station under their own power, for no exceptional storms preceded or attended their coming. On the other hand, it can be shown that drought conditions prevailed at the time to the east of the Chiricahua Mountains and to the north. Perhaps south-migrating birds were diverted westward by a scarcity of water which had transformed accustomed flyways into forbidding passages. Mere vagrant behavior possibly brought about the occurrence of certain individual specimens.

There is a chance, nevertheless, that small numbers of at least several of the species migrate through southeastern Arizona more or less regularly. The site of the Southwestern Research Station would be expected to attract such birds. The Station is located on a valley floor at 5400 feet elevation where near-by precipitous south-facing slopes, with oak trees and grassy expanses, tower above it; the north-facing slopes are generally less steep and their dominant tall tree is Chihuahua pine. Oak woods interspersed with juniper command the bottoms, except where tall riparian trees and grape tangles flourish along stream beds (for a full description see Marshall, Pacific Coast Avifauna no. 32, 1957; for a condensed account see Tanner and Hardy, Amer. Mus. Novit. no. 1866, 1958). At the Station itself are weed patches, an open field, small meadows, permanent springs, and an apple orchard; and Cave Creek circulates across the property beneath and between lush willow thickets, walnut trees, and taller cottonwoods and sycamores. The country surrounding the Chiricahua uplift, in contrast, is largely desert and open live oak woodland of a dry aspect.

A rich oasis for migrating birds is thus comprised. That so many avian species not before recorded from the region were found at this one locality during a single period is an appropriate, and perhaps not a wholly accidental, expression of that fact. In the same connection it should be noted that ornithological research became in 1956 a constant program of the newly-established Research Station, and that the Station's grounds received, accordingly, such careful day-to-day scrutiny as perhaps no comparable habitat of the pine-oak regions in the Southwest has before been accorded during the fall migratory period. As a result, three species were added to the Arizona avifauna in six weeks.

I am indebted to all those persons whose contributions to the present report, and whose names, are cited in the brief species accounts. To Mont Cazier, Director of the Station, and to Allan R. Phillips, I owe particular gratitude, since they many times generously complied with my requests for information. Except where otherwise stated, specimens are located in the synoptic collection at the Southwestern Research Station. All the specimens were secured at or near the Station proper; their identifications were made or confirmed by Allan R. Phillips and in several cases by Joe T. Marshall, Jr.

*Buteo platypterus*. Broad-winged Hawk. An immature female was collected from an oak tree by John Anderson on September 22. The species has not before been recorded west of Colorado.

*Sayornis phoebe*. Eastern Phoebe. Mont Cazier collected a specimen of this species (sex?) from a willow tree at the edge of a field on October 3. The combined effect of two past records (Kimball, Condor 23: 57, 1921) and the present one suggests that *S. phoebe* may be a rather regular fall migrant in the Chiricahua Mountains.

*Contopus virens*. Eastern Wood Pewee. James T. Bialac, on September 16, collected an immature female in a willow thicket. There is only one previous record

(not yet published) of the species from west of the Rocky Mountains. The present specimen is in the A. R. Phillips collection.

*Dumetella carolinensis*. Catbird. Peter Marshall collected an immature bird in a willow thicket on October 13. Although *D. carolinensis* is a breeding bird in central eastern Arizona (Springerville), this is the first southern Arizona record for the species. The Catbird is equally unknown on migration in most or all of New Mexico.

*Toxostoma rufum longicauda*. Brown Thrasher. Two immature males were taken, the first by John Anderson on October 17, the second by William George on December 30. Both birds were located in willow thickets between the Station laboratory and the main house. The species has been taken previously in Arizona but not in the Chiricahuas. The December 30 bird is in the A. R. Phillips collection.

*Dendroica c. caeruleascens*. Black-throated Blue Warbler. A male in apparently adult plumage was collected in a willow grove by John Anderson on October 17. A female of the species, observed moments later in the same place, was not collected. The record is the first for the species from Arizona, but there are at least two specimens and one reliable sight record from central and western New Mexico, in addition to two accidentals taken in California.

*Icterus spurius*. Orchard Oriole. William George collected two juvenal-plumaged males in a weed patch near a willow thicket, the first on September 2, the second (now in the A. R. Phillips collection) on September 8. A third bird was sighted in the same weed patch on September 9. These are the first authenticated records for the species from Arizona. There are no other specimens reported from west of the Great Plains except one vagrant from north-western California.

*Passerina ciris*. Painted Bunting. On August 11, an immature (?) female flew into a bat net strung across the Station's swimming pool and was captured. The specimen is only the second recorded from Arizona during the past forty years and the first since 1933 (Campbell, Condor 36: 203, 1934).—WILLIAM GEORGE, Department of Zoology, University of Arizona, Tucson, Arizona, 8 February, 1958.

**House Martin (*Delichon urbica*) and Canary (*Serinus canaria*) in Bermuda.**—During the past nine years, I have spent a considerable time in Bermuda, observing and collecting birds. This, together with the work of others, has made possible many additions to the last check-list (Bradlee, Mowbray and Eaton, Proc. Boston Soc. Nat. Hist., 39: 279-382, 1931) and a revision is being prepared for publication in the near future. The following records of Old World species seem worthy of immediate publication, as they are of more than local interest.

House Martin (*Delichon urbica*). A single individual, male, (testes, 2 mm.) No. 562 in my collection, was collected out of a flock of nine Barn Swallows, *Hirundo rustica*, in Devonshire Parish, Bermuda, on August 9, 1957. The identity of this specimen was kindly confirmed for me by Dr. Charles Vaurie at the American Museum of Natural History, who ascribes it to the nominate European race. Unfortunately specimens of the Barn Swallows, with which it was observed to keep close company for a full hour and a half prior to being collected, were not obtained, so that it is impossible to say whether these were the European subspecies, *H. r. rustica*, or the American subspecies, *H. r. erythrogaster*, which is a regular and common transient in Bermuda on both spring and fall migrations. The Martin and Barn Swallows were first seen perching on telegraph wires over the main road at noon on August 9. Shortly after, the group took flight and fed actively on flying insects over an adjoining garbage dump and playing field. Wing shots at the Martin were unsuccessful and on two occasions the group circled

up to a great height and almost disappeared in a south-westerly direction. Finally the entire group returned and landed on the same wires about 1:30 P.M. After I collected the Martin the Barn Swallows disappeared for good. There are strong indications that the group, including the Martin, arrived on, or no more than a day previous to August 9, as most of the Island, and particularly the locality concerned was being regularly checked. I have not examined official weather data for the whole North Atlantic at this period, but local weather for a considerable time before and after this record was very adverse for the occurrence of any European straggler. The air mass overlying Bermuda during July and August was warm, very humid and unstable, with heavy rainfall, and thunderstorms almost daily. The wind was almost continually strong South-West to West.

Canary (*Serinus canaria*). The identity of this species was also confirmed by Dr. Charles Vaurie, who kindly examined my single Bermuda specimen, No. 260, sex?, little fat, wt. 15.2 gms., collected on August 31, 1956, from a live cedar, *Juniperus bermudiana*, in a valley near Burnt Hill, Warwick Parish. The specimen agrees in plumage with male wild Canaries of the Azores, Madeira and Canary Islands. My inquiries of Bermudians familiar with the wild Canary indicate that it may not have been here for more than 25 to 30 years. However, it may have been overlooked before this. The possibility of the Canary being native is remote. Probably it was introduced some time between 1870 and 1930. Many people from the Azores Islands have come to Bermuda over the years to work on farms, or to settle in Bermuda, and possibly brought caged wild Canaries with them, which subsequently escaped or were released. The European Goldfinch (*Carduelis carduelis*), now a common resident, was introduced in this manner more than once between 1870 and 1900. My observations indicate that there is only a small population of Canaries, probably not exceeding 25 pairs, resident and breeding in the wild in Bermuda. The Canary is not island-wide. In 1957 I found it only on the South Shore of the western half of the Islands from Warwick Parish to Daniel's Head in Sandys Parish. In 1950 and 1951 it occurred as far east as Smith's Parish, a single pair being found near Spittal Pond in those years. The recent destruction of the Bermuda Cedar forest between 1946-1952 by a scale disease (*Carulaspis minima*) appears to have caused a slight decrease in numbers, which may continue. The Canary was largely dependent on the cedar for shelter and nesting sites and because this tree was the *only* forest cover in many areas, much of the former habitat has been ruined. Evidence of breeding is provided by the following observations: In 1950, a pair was observed nest building in the top of a live cedar on April 16. The nest was finished when checked on April 19, and not checked again until May 1st, when it was found to be empty. In 1951, a pair bred successfully in the same locality, completing a nest between March 27 and April 1. This nest contained two half-grown young when examined on April 28. Between September and January I have occasionally observed small groups of four or six birds, usually with a pair of adults and a varying number of immatures showing hardly any yellow at all in the plumage.—DAVID B. WINGATE, "Aldie," Smith's Parish, Bermuda.

## REVIEWS

**Les Migrations des Oiseaux.**—Jean Dorst. 1956. Payot, Paris. 422 pp., 94 figs. Paper bound, 1500 francs. This is a well organized review of bird migration. Modern, as well as some older, theories, and the experimental data on which they rest, are discussed, including a number of papers published as recently as 1953-1954. Important knowledge has been gained, particularly as regards orientation and determining physiological factors, but it remains scattered. The complex problems of migration are still far from understood. Before discussing physiology, orientation, the origin and evolution of migration, and other related subjects, the author presents a series of introductory chapters. In one, methods of study are treated; other chapters review the pattern of migration in the various regions of the world. The geographic chapters are somewhat unbalanced. For instance, 73 pages of text, with an accompanying bibliography of 98 titles, are devoted to "Europe and northern Asia" (but chiefly to Europe), whereas only 18 pages with 12 titles are devoted to North America, although migration is more marked in North America than in Europe and has a vast literature. The North American reader should, however, welcome the fuller treatment accorded to the less familiar European data. Bibliographies accompany each chapter, and some of these are very extensive. Many works on migration are not easy to read, but the present one is a model of clarity and is well illustrated by good maps and diagrams.—C. VAURIE.

**Life histories of North American Blackbirds, Orioles, Tanagers, and their allies. Order Passeriformes: Families Ploceidae, Icteridae, and Thraupidae.**—Arthur Cleveland Bent. 1958. U. S. Natl. Mus. Bull., 211. 549 pp., 37 photog. pls. Superintendent of Documents, Washington 25, D. C. \$2.25. The twentieth volume of this series brings Bent's great work close to completion. At his death on December 30, 1954, in his eighty-ninth year, only the Fringillidae manuscript remained to be finished. Fortunately a committee will see the series through. This book follows the familiar format, with some differences in typography. According to the introduction, the manuscript was completed in 1949 (though the distributional information seems later), so there is some divergence between the English and technical nomenclature and that of the 1957 A. O. U. Check-list—especially in the retention of subspecific vernaculars. The Spotted-breasted Oriole now nesting in Florida is not included. While few of the references postdate 1940, this book conveniently summarizes most of the significant data that appeared prior to that time. It is to be hoped that there will be less of a gap between completion of the manuscript and the publication of the final volume or volumes. The price makes the book a rare bargain.—E. EISENMANN.

**A Company of Birds.**—Loke Wan Tho. 1957. Michael Joseph Ltd., 26 Bloomsbury St., London. 174 pp., 109 photos, 1 in color. 42 shillings. All of us who have admired Mr. Loke's beautiful bird photographs have hoped for many years that he would bring some of them together and publish them in book form. This, he has now done, and I am happy to report that they have lost little in reproduction. Loke is not only a photographer but also an ornithologist who has the patience to wait until he can take a biologically meaningful action picture. The birds shown occur in India, Malaya, and New Guinea. Many, if not most, of the birds in this volume have never been photographed before, and it gives me particular pleasure to find magnificent portraits of some of my old friends from the New Guinea mountain forest. The previously unknown nests of several New

Guinea species are also depicted. There is an introduction with hints on photography in the tropics. We are most grateful to Loke Wan Tho for sharing with us his treasure of beautiful bird portraits.—ERNST MAYR.

**The Arctic Year.**—Peter Freuchen and Finn Salomonsen. 1958. 438 pp.; numerous line drawings and maps. G. P. Putnam's Sons, New York. \$5.95. This book, a month-by-month account of life in the Arctic, is crammed with fascinating information—much of it ornithological, as is to be expected of the junior author, the prime expert on Greenland birds. A fine introductory chapter defines the Arctic as the region above tree line, points out the differences between the low-arctic and high-arctic regions, and sketches the basic factors affecting the distribution of plant and animal life, including the Pleistocene glaciation. This chapter contains a number of useful maps, but unfortunately there is a confusing transposition of legends under the maps on pages 8 and 16. The remainder of the book is devoted to an account of what is happening to the environment during each month and what the living creatures are doing. There is much unfamiliar data and stimulating speculation. In the discussion of Bergmann's rule (warm-blooded animals tend to be larger in colder areas, as increased size results in a relatively smaller outer surface, thus diminishing heat loss), it is pointed out that big animals living in areas where food is meagre, particularly in the high-arctic, may be reduced in size despite colder climate, because a large animal needs more food than a smaller one. This is suggested as a possible reason why the Arctic Whistling Swan is smaller than the more southern Trumpeter, Whooper, and Mute Swans. Arctic whiteness may have a function other than concealing, for in the high-arctic, where there is relatively little snow and much of the landscape, even in winter, is exposed rock, animals are whiter than in the low-arctic. The idea is advanced that lack of pigment within a feather or hair may leave an air space which may serve as insulation against cold. The molt migration of drake King Eiders from Canada to form an unsurpassed concentration of flightless waterfowl on the west coast of Greenland is vividly described and illustrated by a map. The arrangement by months and the lack of subheadings or formal organization within chapters make use as a reference work somewhat difficult. This book, after all, is designed for the general reader. But the serious student is aided by an index and a bibliography. Although perhaps half the text relates details of the daily life and special viewpoint of the Eskimos, their remarkable sexual customs are, surprisingly, passed over in silence. One suspects prudishness in the publisher.—E. EISENMANN.

**The Ornithologists' Guide. Especially for Overseas.**—Edited by Major-General H. P. W. Hutson. 1956. 275 pp., 34 text figs. British Ornithologists' Union. H. F. & G. Witherby Ltd. London. 21s. While designed primarily for bird students living away from the main currents of ornithological activity, to point out rewarding subjects and methods for serious bird-watching, this book should prove stimulating to amateurs anywhere. There are over fifty chapters, running from two to six pages, covering a variety of subjects, written by forty-six contributors, including most of the leading British ornithologists, as well as a few from other countries. The emphasis is on observational studies. Many of the articles, though their purpose is to suggest techniques or phases of behavior meriting study, are in themselves interesting and ornithologically informative. Here are described a variety of subjects, appealing to a variety of temperaments, on which a keen observer may contribute new and needed information, without

leaving his own area, without elaborate apparatus, and without long-term devotion to meticulous detail.

The section on "Regional Information" is planned to assemble the names of ornithological societies, bird collections, resident ornithologists, and the most useful bird publications in the ornithologically less developed countries of the world (i.e., everywhere outside of Europe, Canada and the United States). The information for Africa, Asia, and Australasia seems good and reasonably up-to-date, some cited literature being as recent as 1955. Unfortunately the same cannot be said for the New World information. Omitted is mention of fundamental reference works like Ridgway and Friedmann, "Birds of North and Middle America" and Cory, Hellmayr and Conover, "Catalogue of Birds of the Americas." For Brazil only "The Birds of Matto Grosso" is listed, while the major (and more recent) distributional compendium, Pinto's "Catalogo das Aves do Brasil" is overlooked, as well as Goeldi's old, but illustrated, "Album das Aves Amazonicas." It seems strange for a British book to omit Chubb's "Birds of British Guiana." Under the heading "Sea-Routes and Polar Regions" one fails to find the most valuable and enthralling bird book on the southern seas, Murphy's "Oceanic Birds of South America," still procurable at a very low price. For Mexico only Blake's fine book is listed, but there is no mention at all of major distributional works on El Salvador, Costa Rica and Panama (see bibliography in my "The Species of Middle American Birds"). With so many requests from persons going abroad for books bearing on identification and distribution of birds, it is disappointing that the more useful Western Hemisphere literature was not compiled with the care devoted to the Eastern Hemisphere. In other respects "The Ornithologists' Guide" should prove as useful to students in the New World as in the Old.—E. EISENMANN.

**The Bird Life of Great Salt Lake.**—By William H. Behle. University of Utah Press, Salt Lake City, Utah. 203 pp., 43 figs. (photos, linedrawings, maps). Cloth, \$4.50. 1958. The subtitle, "The Life History, Ecology and Population Trends of the California Gulls, White Pelicans, Double-crested Cormorants and Great Blue Herons, Together with an Account of the Bear River Migratory Bird Refuge," outlines the chief subject-matter of this book. Some details are also given of the Caspian Terns that intermittently breed on islands in the Great Salt Lake, and there are distributional lists of the other species recorded from the various islands and from the Bear River Refuge. A major ornithological interest of Great Salt Lake is the nesting on small islands of colonial fish-eating birds, which must travel round-trip daily a minimum of seventy-five or a hundred miles to provide food for their young, as the Lake is too saline to support fish. Only the omnivorous California Gulls get some sustenance from the local brine flies and brine shrimp, and these do not suffice for their needs. The attraction of the barren islets in the Lake is their isolation from disturbance and absence of mammalian predators. Very full treatment is provided of the California Gull and White Pelican, including molts and plumages. Yet we still do not know the incubation period of the pelican and there is uncertainty whether the California Gull breeds in its third year (some few individuals apparently do). Despite lack of food, Great Salt Lake serves as a resting place for migrant water-fowl and phalaropes. The alkaline Bear River Marshes at the northeast corner of the Lake are justly famous for the millions of migrant ducks, as well as for many spectacular breeding species. Water control by diking of this great refuge has not only reduced the scourge

of botulism, but has greatly facilitated bird-study. It is good to have an authoritative account of this most interesting area.—E. EISENMANN.

**Birds of Pine-Oak Woodland in Southern Arizona and Adjacent Mexico.**—Joe T. Marshall, Jr. 1957. 125 pp., 2 col. pls., 26 text figs. Cooper Orn. Soc. Berkeley, Calif. Pac. Coast. Avi. no. 32. \$4 (paper); \$5 (buckram). Woodland of mixed pines and oaks is characteristic between 5500 to 6000 feet in southeastern Arizona—an extension of a more widely distributed belt in the mountains of Mexico. This report treats the birds of this habitat in Arizona and the nearby parts of Sonora and Chihuahua, with major emphasis on their ecology. The floristic composition is elaborately discussed. Censuses were made in various localities to determine numbers and habitat preferences. Tables show feeding sites used by the various species, their favored habitats in order of preference, and the species whose northern and southern limits occur in the area. Marshall found no evidence of ecological or altitudinal races, and he questions the assumption that subspecies are genetically disposed to select different habitats. In his view, a population uses whatever local manifestations of the overall species niche is available, which may seem very unlike until the basic requirement is understood. The adoption of truly different niches by island populations is made possible by the absence of competitors that normally occupy such niches. Interspecific competition in the study area is interestingly discussed. A species by species account, chiefly devoted to miscellaneous life-history observations, forms the second part of the book. The many photographs help in visualization of the habitats, and there are three half-tones and two color plates of birds by Don Eckelberry.—E. EISENMANN.

**Birds and Men. American Birds in Science, Art, Literature, and Conservation.** 1800–1900. Robert Henry Welker. 1955. 230 pp., 40 half-tones. Belknap Press, Cambridge, Mass. \$5.75. A general account, with many interesting reproductions of old illustrations, of the growth of interest in birds in the United States during the last century.—The emphasis is definitely not on the science of ornithology, but on the popular aspects.

**Bird Life.** Niko Tinbergen. 1954. 64 pp., 1 col. pl., numerous text figs. and photos. Oxford Univ. Press. \$2.75. An elementary but stimulating account of various aspects of bird behavior, with suggestions for the beginner in bird-watching, written by one of the leaders in this field. Examples are drawn from European birds.

**A Handbook of Elementary Bird Study.**—P. A. Bourke. 1955. 172 pp., 8 col. pls., 20 photos., 14 text figs. Patterson Brokensha Pty. Ltd. Perth, Western Australia. A book on bird-watching techniques for Australians (not an identification manual), with chapters on teaching bird study and on activities for school branches of the Gould League (the Australian equivalent of Junior Audubon Clubs).

## RECENT LITERATURE

EDITED BY FRANK McKINNEY

## ANATOMY AND EMBRYOLOGY

- LAHRMAN, F. W. 1958. Surf Scoter records. Blue Jay, **16**(1) : 18.—Records from Saskatchewan, including a bird whose breast bone had been shattered, apparently by shot, but had healed completely in an odd shape, and whose gizzard also indicated a healed gun shot wound with an encisted pellet.
- OEMING, A. F. 1958. Goshawk trapping in Alberta. Blue Jay, **16**(1) : 8-10.—Gives the weights of 54 *Accipiter (Astur) gentilis atricapillus* trapped in Alberta between 1952-1957, with dates, sex and whether in immature or adult plumage. Of the birds trapped 27 were males (6 adults, 21 immature) and 27 were females (12 adults, 15 immature). Males averaged 1 lb. 14.3 oz., females 2 lb. 8.7 oz.
- WALLMO, O. C. 1956. Determination of sex and age of scaled quail. Journ. Wildl. Mgt., **20** : 154-158.—Sexes are best distinguished by examination of plumage about face and throat. Males characterized by uniform pearl grey plumage about face, and white to buffy plumage on throat; females show grey to greyish-white plumage, with longitudinal dark streaks about both face and throat. Age determination of juveniles is based on replacement and growth of primary feathers during post-juvenile molt. Juveniles retain outer two primaries in post-juvenile molt; these feathers are distinguishable from comparable adult-primaries. Juveniles show mottled primary wing coverts (with exception of outer two) until first post-nuptial molt; adults have uniformly grey wing coverts.—R. F. L.
- WILLIAMSON, K. 1957. Post-breeding Molt of Crossbills. Scot. Nat., **69**(3) : 190-192. Molt of *Loxia c. curvirostra* trapped at Fair Isle, Scotland.

## BEHAVIOR

- DARNTON, I. 1958. The display of the manakin *M. manacus*. Ibis, **100** : 52-58.—These observations on the Black-and-white Manakin were made on Trinidad from February 11 to March 16, in which time manakins were breeding. The display arenas (constructed by ♂♂), behavior and displays of both ♂♂ and ♀♀ there, vocalizations and other sounds made, and the chronology of daily activities are described.—R. F. J.
- FLINCHBAUGH, J. K. 1958. An unusual bird roost. Jack-Pine Warbler, **36**(1) : 21.—Black-capped Chickadee roosting in a cup nest.
- FRINGS, H., M. FRINGS, J. JUMBER, R.-G. BUSNEL, J. GUIBAN and P. GRAMET. 1958.—Reactions of American and French species of *Corvus* and *Larus* to recorded communication signals tested reciprocally. Ecol., **39** : 126-131. Individuals exposed only to communication signals of their own species or regional group become quite specific in reaction and do not respond to signals from other groups. Where individuals mingle with other groups of their own or other species they may learn to respond to signals of these.—S. C. K.
- GORDON, S. 1957. Coition of Golden Eagles in Skye. Scot. Nat., **69**(3) : 183-184.
- KURODA, N. 1957. Anting by the Gray Starling *Sturnus cineraceus* Temminck. Tori, **14**(69) : 28.—Anting with *Formica fusca japonica*. (In Japanese; English summary).—E. E.
- LAHRMAN, F. W. 1958. Western Grebe. Blue Jay, **16**(1) : 16-17. Photos of nesting and behavior, including the "water dance."

SOUTHERN, W. E. 1958 Myrtle Warbler feigns injury. Jack-Pine Warbler, **36**(1) : 27.—Injury feigning by female Myrtle Warbler described, and similar behavior in Kirtland's and Yellow Warblers mentioned.—E. E.

WATSON, A. 1957. Golden Eagle display in late June. Scot. Nat., **69**(3) : 184.

#### DISEASES AND PARASITES

DÖRING, E. 1958. Plagen durch verwilderte Haustauben. Orn. Mitteil., **10**(3) : 41–46.—Diseases carried by feral Domestic Pigeons.

WARD, R. A. 1957. A study of the host distribution and some relationships of biting lice (Mallophaga) parasitic on birds of the order Tinamiformes. Parts 1 and 2. Am. Entomol. Soc. America, **50** : 335–353, 452–459.—Part 1 deals largely with the taxonomy of the mallophaga and their tinamous hosts. Von Boettischer's classification of tinamous is in general supported, except that on the basis of their mallophaga *Nothocercus* is closer to *Crypturellus* than to *Tinamus*. Part 2 deals with the microgeographic distribution of mallophaga. Small tinamous harbor about the same number of mallophaga species as larger tinamous, but the mallophaga are smaller kinds. The restriction of some mallophaga to particular feather tracts and the frequent presence of certain genera together in the same tract are discussed.—E. E.

#### DISTRIBUTION AND ANNOTATED LISTS

- AVELEDO H., RAMÓN. 1957. Aves de la Región del Rio Guasare. Bol. Soc. Venez. Cien. Nat., 18, no. **88** : 73–100.—Annotated list of a collection in Venezuela; *Ortalis r. ruficrissa* and *Myrmeciza longipes panamensis* added. (In Spanish.)
- BAXTER, E. V. 1957. Review of ornithological changes in Scotland in 1956. Scot. Nat. **69**(3) : 170–177.—Least Sandpiper taken in Shetland, Aug. 14, 1955.
- BEE, J. W. 1958. Birds found on the Arctic slope of northern Alaska. Univ. Kansas Publ., Mus. Nat. Hist., **10**(5) : 163–211, 2 pls., 1 text fig.—Distributional and life-history data on 73 species collected or observed in the summers of 1951 and 1952.
- BINDING, W., H. DUCHROW, J. GROTE and G. VAUK. 1948.—Fang eines Rotaugen-Vireo (*Vireo olivaceus* L.) auf Helgoland. Erster Nachweis für Deutschland. J. f. Orn., **99** : 100–101.—First Red-eyed Vireo taken in Germany at Helgoland on Oct. 4, 1957.
- BOND, J. 1958. Third supplement to the Check-list of Birds of the West Indies (1956). 11 pp. Acad. Nat. Sci. Phila. Distributional and taxonomic notes, additions and corrections.
- BURNS, R. D. 1958. A history of the entry of the Cardinal into Michigan. Jack-Pine Warbler, **36**(1) : 19–21.
- CHENG, T.-H., T.-H. PAN and J.-CH. TANG. 1957. New records of Chinese birds from southern Yunnan. Acta Zoologica Sinica, **9**(3) : 34–45; 2 color pls. (In Chinese; full English summary.)
- DEKEYSER, P. L. 1956. Le Parc National du Niokolo-Koba: Oiseaux. Mem. de l'Institut Français d'Afrique Noire, **48**(1) : 79–141.—Birds observed or recorded in Niokolo-Koba Park, Senegal, comprising 154 species. The number is small enough to suggest that the list is hardly more than a first, preliminary one. Detailed measurements are given for all the specimens collected, even where no questions of variation are raised or implied. Because of the limited literature

- on Senegambian birds, the list has a usefulness, although none of the records are surprising.—H. F.
- GARDEN, E. A., G. F. RAEURN, A. TEWNION, V. M. THOM. 1957. Baldpate (American Wigeon) in Aberdeenshire. *Scot. Nat.*, **69**(3): 196.—A male *Anas (Mareca) americana* observed May 4-5, 1957 in Scotland with ten European Wigeon.
- HARDY, J. W. and N. L. FORD. 1957. A second specimen of the Golden-winged Warbler from Kansas. *Kansas Orn. Soc. Bull.*, **8**(1): 8.
- HARDY, J. H. 1957. First specimen from Kansas of Swainson's Warbler. *Kansas Orn. Soc. Bull.*, **8**(2): 10.
- HASHIMOTO, T. 1957. On a specimen of *Calidris bairdii* collected in Ise, Mie Prefecture. *Tori*, **14**(69): 25-28.—The first record for Baird's Sandpiper from Japan proper, Sept. 1, 1956. There is a previous record from the North Kuriles. (In Japanese; English summary.)—E. E.
- HAYS, H. E., JR. 1956. Nesting record of the Song Sparrow in Kansas. *Kansas Orn. Soc. Bull.*, **7**(4): 20.
- HOUSTON, S. 1958. An evaluation of the distribution records for Saskatchewan birds in the revised edition of the A.O.U. Check-list. *Blue Jay*, **16**(1): 44-47.—Points out errors in records relating to Saskatchewan, as well as range extensions.
- LIGAS, F. J. 1958. Cattle Egret (*Bubulcus ibis*). *Florida Nat.* **31**: 25.—A nestling Cattle Egret, banded at Lake Okeechobee, Florida on June 10, 1956 (No. 576-49149) was shot in Mexico, at Laguna Om, near Chetumal, Quintana Roo on December 16, 1956. Apparently the first Mexican record.—E. E.
- MACDONALD, J. D. Contribution to the ornithology of western South Africa. Results of the British Museum (Natural History) South West Africa Expedition, 1949-50. *Brit. Mus.*, London, England. £ 1, 15 s. 1-174. 7 photo. pls., maps, figs.—A list of 235 species, mainly taken in the desert or semi-desert regions, with elaborate notes on taxonomy and behavior. The preliminary discussion of the effect of climate on breeding season and of soil color on the appearance of desert birds is especially interesting. New subspecies described: *Streptopelia capicola onguati*, *Bradornis infuscata namaquensis*, *Fringilla (sic = Fringillaria) impetuani sloggetti*.—E. E.
- MORIOKA, H. 1957. *Emberiza pallasi* (Cabani) from Japan. *Tori*, **14**(69): 23-25.—First records of *E. p. pallasi* and *E. p. polaris*. (In Japanese; English summary.)
- NELSON, T. 1956. The history of ornithology at the University of Michigan Biological Station, 1909-1955. 106 pp. Burgess Publishing Co., Minneapolis, Minn.—An account of the activities at the station, including a list of papers written and an annotated check-list of birds observed in the vicinity (the northern part of the Lower Peninsula of Michigan).
- NOVAES, F. C. 1957. Contribuição à ornitologia do noroeste do Acre. *Bol. Mus. Paraense Emílio Goeldi. Zool.* no. **9**: 1-30.—Annotated list of birds collected on an expedition to northwestern territory of Acre, Brazil. (In Portuguese.)—E. E.
- ORIANS, G. and E. ORIANS. 1957. A contribution to the ornithology of the Vesterølen Islands. *Sterna*, **2**(4): 131-135.—Nesting data from Andya, a Norwegian arctic island.
- PETTINGILL, O. S., JR. 1958. Notes on the birds of the Straits Region, Michigan.

- Jack-Pine Warbler, 36(1) : 7-11.—Additions to the list published in 1956 by T. Nelson, including some birds from north of the Straits of Mackinac.
- PHILPS, W. H. and W. H. PHELPS, JR. 1957. Las aves de Isla de Aves, Venezuela. Bol. Venez. Cien. Nat., 18, no. 88: 63-72.—Birds of a tiny islet in the Caribbean; Sooty Terns and Brown Noddies were nesting. (In Spanish.)
- ROOT, O. M. 1957-58. The birds of the Andover region. Bull. Mass. Aud. Soc., 41: 459-467, 42: 5-15, 79-87, 119-125.—Distributional list for region about Andover, Essex County, Massachusetts, with useful data on numbers and changes of status.—E. E.
- RUSCHI, A. 1951. Trochilideos do Museu Nacional. Bol. Museu de Biologia Prof. Mello-Leitão, 10: 1-111. Santa Tereza, Espírito Santo, Brazil.—A list of the hummingbirds in the National Museum of Brazil, giving the locality of each specimen, the distribution, and the literature relating to each form. The last twenty-five pages provide general biologic information as to the family, and behavior and breeding data as to a number of species studied in life by the author. The author is a hummingbird specialist, interested especially in the natural history of these birds, and has published as bulletins of the Mus. de Biologia Prof. Mello-Leitão, maintained by him, a number of earlier and more detailed studies containing much otherwise unknown life history data. Most of these earlier papers are cited in this paper under the name of the hummingbird involved.—E. E.
- RUSCHI, A. 1953. Lista das Aves do Espírito Santo. Bol. Museu de Biologia Prof. Mello-Leitão, 11: 1-21. Santa Tereza, Espírito Santo, Brazil.—List of the birds of the Brazilian state of Espírito Santo.
- SICK, H. 1957. Vom Hausspatzen (*Passer domesticus*) in Brasilien. Vogelwelt, 78(1) : 1-18. The House Sparrow, introduced into Argentina in 1872, now ranges in Brazil north to Mato Grosso and Goias, but has so far been unable to maintain itself in the humid areas of Amazonia. Its general biology in Brazil is discussed. In southeastern Brazil, birds carrying nesting material have been noted throughout the year; the clutch seems most often to be two (smaller than in Europe.) (In German.)—E. E.
- SMYTHIES, B. E. 1957. An annotated Check-list of the birds of Borneo. Sarawak Mus. Jour., 7 (9 n.s.) : viii-xv + 523-818.—The first detailed, modern list for the great Malaysian island. 552 full species are included. English names are provided for species. Ecological as well as distributional data are supplied and some information as to status. Good bibliography, locality index and map.—E. E.
- THOMPSON, M. 1957. Additional records of birds from south-central Kansas. Kansas Orn. Soc. Bull., 8(3) : 1957.
- URBAN, E. K. 1957. Birds observed at Resolute Bay, Cornwallis Island, Northwest Territories. Passenger Pigeon, 1957: 73-75.
- WATSON, A. 1957. Notes on birds in Arctic Norway. Sterna, 2(3) : 65-99.—Observations, chiefly in Lofoten and Lyngen peninsula, during the summers 1950-1952 and 1955. (In English.)
- WILLIAMSON, K. and H. G. ALEXANDER. 1957. Semipalmated Sandpiper at Fair Isle: a bird new to Scotland. Scot. Nat., 69(3) : 145-147.—*Calidris (Ereunetes) pusillus* present May 28-June 3, 1956, captured with a mist-net for identification, and then released; the third British record. Another American bird, the Olive-backed Thrush, was found dead in County Mayo, Eire on May 26. Both may have been carried by a westerly air stream that covered the North Atlantic for several days previously.

- WILSON, D. R. 1958. Leach's Petrels in Shetland. *Brit. Birds*, **51**: 77.—Possibly breeding.

## ECOLOGY AND POPULATION

- BARD, F. G. 1958. Whooping Cranes, 1958. *Blue Jay*, **16**(1): 11–14.—The status of this species, especially in Saskatchewan, with photos, of four observed on Oct. 13, 1957. The touristic value of birds is indicated by the statement that in 1957 these cranes drew 33,000 visitors to the Aransas Refuge in Texas.
- BLACKITH, R. E. 1958. Nearest-neighbour distance measurements for the estimation of animal populations. *Ecol.*, **39**: 147–150.
- BOND, R. R. 1957. Ecological distribution of breeding birds in the upland forests of southern Wisconsin. *Ecol. Mon.*, **27**: 351–384.—Analysis of microhabitat and niche distribution of birds in the deciduous forest bioclimatic, especially in relation to the gradient from xeric to mesic forests.—S. C. K.
- BRAAKSMA, S. 1957. Pleisterplaatsen van Kraanvogels, *Grus grus* L., in Nederland. *Ardea*, **45**: 143–167.—The status and character of the roosting and feeding areas in the Netherlands of the Eurasian Crane. (In Dutch; English summary.)
- EGENRAAM, J. A. 1957. The sex-ratio and the production of the Mallard (*Anas platyrhynchos* L.). *Ardea*, **45**: 117–143.—In the Netherlands the sex ratio is not static but for every 100 females fluctuates from 106 males just before the breeding season, to some figure exceeding 114 males prior to the hunting season.—E. E. KOZICKY, E. L., R. J. JESSEN, and G. O. HENDRICKSON. 1956. Estimation of fall quail populations in Iowa. *Journ. Wildl. Mgt.*, **20**: 97–104.—Fall census data for 32 Iowa counties from 1939 through 1953 indicated the peak occupancy of quail ranges in 1939; the low in 1953. Forty-acre, random sample plots are suggested as a means of estimating annual, statewide population changes. Based on the probability of quail occupancy in October, quail ranges were classified into three types of strata or 40-acre plots; aerial photos were effective in classifying strata. Sampling methods were investigated: (1) simple random, (2) stratified random with proportional allocation of 40-acre plots, and (3) stratified random with optimum allocation of 40-acre plots; these sampling schemes were also tested with matched and unmatched 40-acre plots to determine efficiency in sampling the same plots each year. Incomplete matching with stratified optimum allocation is indicated as the most efficient scheme for estimating annual changes in quail occupancy of 40-acre plots.—R. F. L.
- MACARTHUR, R. H. 1958. A note on stationary age distributions in single-species populations and stationary species populations in a community. *Ecol.*, **39**: 146–147.—Mathematical.—S. C. K.
- ROBINSON, T. S. 1957. Climate and Bobwhites in Kansas in 1956. *Trans. Kansas Acad. Sci.*, **60**(3): 283–287.
- ROOTH, J. 1957. Over het voedsel, de terreinkeus en de achteruitgang van de Ooievaar, *Ciconia ciconia* L., in Nederland. *Ardea*, **45**: 93–116. On the food, habitat, and population decline of the White Stork in the Netherlands. (In Dutch; full English summary.)
- SANDEMAN, P. A. 1957. The breeding success of Golden Eagles in the southern Grampians. *Scot. Nat.*, **69**(3): 148–152.—Data from Scotland.
- WATSON, A. 1957. The breeding success of Golden Eagles in the north-east Highlands. *Scot. Nat.*, **69**(3): 153–169.—Much data, including hunting territory, population density, from Scotland.

## EVOLUTION AND GENETICS

VAN BRINK, J. M., and G. A. UBRÉZ. 1956. La question des hétérochromosomes chez les Sauropsidés. Oiseaux. *Experientia*, **12**: 162-164.—It is concluded that a determination of the exact number of chromosomes in the domestic fowl is "beyond the possibilities of cytology." The fifth largest chromosomal element in the domestic fowl is the sex chromosome, and the digamety might be either of the Z-O or Z-W type.—P. H. B.

UDAGAWA, T. 1957. Karyogram studies in birds. IX. The chromosomes of five species of thrushes (Turdidae). *Jour. Fac. Sci., Hokkaido Univ., Ser. VI, Zool.*, **13**(1-4) : 338-343.—The diploid chromosomal number is reported as 84 for spermatogonia of *Turdus a. aureus* (83 oog.), *T. sibiricus davisoni* (83 oog.), *T. o. obscurus*, and *T. n. naumanni* and as 78 for spermatogonia of *Luscinia k. komadori*.—P. H. B.

UDAGAWA, T. 1956. Karyogram studies in birds. VII. The chromosomes of five species of the Limicola. *Annot. Zool. Jap.*, **29**: 219-224.—Chromosomal numbers are presented from germ cells of *Tringa incana brevipes* (86 spg.), *Calidris r. ruficollis* (86 spg.), *Scolopax r. rusticola* (84 spg.), *Charadrius dominicus fulvus* (78 spg.), *C. alexandrinus dealbatus* (78 spg., 77 oog.).—P. H. B.

UDAGAWA, T. 1956. Karyogram studies in birds. VIII. The chromosomes of some species of the Turdidae and Troglodytiidae. *Jap. Jour. Zool.*, **12**(1) : 105-111.—Chromosome counts from germ cells are given for *Turdus cardis* (84 spg., 83 oog.), *Luscinia a. akihige* (78 spg.), *L. a. tanensis* (78 spg.), *Troglodytes t. fumigatus* (86 spg., 85 oog.), *Cinclus pallasi hondoensis* (80 spg.).—P. H. B.

## GENERAL BIOLOGY

BELLARD PIETRI, E. DE. 1957. El Guácharo. *Bol. Soc. Venez. Cienc. Nat.*, **18**: 3-41.—A general account of *Steatornis caripensis*, with detailed distributional information as to the caves known to be occupied by this rare species. (In Spanish; English summary.)

CHENG, T.-H., H.-K. CHIA, SH.-S. FU, and I-CH. WANG. 1957. Food analysis of the Tree-Sparrow (*Passer montanus saturatus*). *Acta Zoologica Sinica*, **9**(3) : 256-266.—(In Chinese; English summary.)

CHENG, T.H., Y.-W. CHEN, SH.-S. FU, and I-CH. WANG. 1958. Studies on the more important insect-eating birds found to occur in the fruit-producing district of Chang-Le, Hopei province. 135 pp., 5 photo pls., 2 color pls., 47 line engravings. Zoological Institute, Academia Sinica, Peking, China. (In Chinese; English summary.)

COULSON, J. C., and E. WHITE. 1958. The effect of age on the breeding biology of the Kittiwake *Rissa tridactyla*. *Ibis*, **100**: 40-51.—Older birds (those having bred at least once before) returned to the colony site earlier and began breeding earlier, showed greater nest-site tenacity, laid larger clutches, had higher nesting success, and were more successful in feeding their young, all as compared with younger birds (those never having bred before).—R. F. J.

DAVIS, T. A. W. 1958. The displays and nests of three forest hummingbirds of British Guiana. *Ibis*, **100**: 31-39.—Notes are given on habitat preference, field characters used in identification, displays, nests, and nesting of *Phaeothornis superciliosus*, *P. ruber*, and *Topasa pella*. Each of these species has communal display of males.—R. F. J.

- DE CARVALHO, C. T. 1957. Relações Biológicas entre *Columbigallina passerina* e *C. talpacoti* (Aves, Columbidae). Bol. Mus. Paraense Emilio Goeldi, Zool., no. 7: 1-15. A comparison of the ecology and behavior in Belém, Brazil of the Common and Ruddy Ground-Doves. (Portuguese; English summary).—E. E.
- DRINNAN, R. E. 1957. The winter feeding of the oystercatcher (*Haematopus ostralegus*) on the edible cockle (*Cardium edule*). Jour. Animal Ecol., **26**(2): 441-469. 315 cockles 20-30 mm. in length or 214 cockles 25-35 mm. in length may be eaten by a bird in a day's time. Of the total mortality in the cockle population of 73.8 per cent, 21.9 per cent was due to predation by the oystercatchers.—S. C. K.
- EPPER, A. W. 1956. Differences in vulnerability of the prey of nesting kingfishers. Journ. Wildl. Mgt., **20**: 177-183.—Discusses the food of nesting kingfishers in relation to existing proportions of stream fauna; the food consumed by kingfishers was determined by counts of identifiable bones from the debris of two evacuated nests. The food intake was divided almost equally between fish and crayfish; no other animals were represented. Kingfishers did not take all prey species in proportion to their abundance in the stream; the differences in the vulnerability of prey may be reflected by the size of prey species and/or the breeding or spawning habits of certain species.—R. F. L.
- FREER, M. F. 1958. Observations on a nesting of the Black-throated Blue Warbler. Jack-Pine Warbler, **36**(1): 12-16.—Attentive periods. After losing two eggs in a storm, female incubated the remaining (infertile) egg for 20 days, bringing food to the nest twice on the twelfth day, when hatching would have normally occurred.—E. E.
- GROSS, A. O. 1958. The Bananaquit. Florida Nat., **31**(1): 3-8.—An account of the enormous abundance and tameness of *Coereba flaveola* on Tobago, B.W.I., with data on nests, incubation and nestling periods, song, and feeding behavior.—E. E.
- HAGA, R. 1957. A record of nesting of White-tailed Sea-eagle at Nemuro Peninsula, Hokkaido. Tori, **14**(69): 18-22. Description (with photos.) of two nests of *Haliaeetus albicilla* in Japan, one at the top of a fir, the other, used for two successive years, on a birch 14 meters up. Young in both nests were fed on fish and crows (*Corvus levaillantii* and *Corvus corone*). (In Japanese with English summary).—E. E.
- HAVERSCHMIDT, F. 1957. Notes on the Cattle Egret in Surinam. Ardea, **45**: 168-176.—At a roost at Nieuw Nickerie the population increased from 1,825 in 1953 to 5,576 in 1956. In 1957, nests were found in this roost during May and June. In British Guiana the birds breed in the Botanic Garden of Georgetown. Data on food and behavior.—E. E.
- HOYT, S. F. 1957. The ecology of the Pileated Woodpecker. Ecol., **38**: 246-256.—Summary of doctorate studies of her late husband on life-history, abundance and food-relations of this species.—S. C. K.
- INGRAM, C. 1958. Notes on the habits and structure of the Guacharo *Steatornis caripensis*. Ibis, **100**: 113-119.—The notes concern the rictal bristles, and the tarsometatarsus and hallux.—R. F. J.
- KESSEL, B. 1957. A study of the breeding biology of the European Starling (*Sturnus vulgaris* L.) in North America. Amer. Mid. Nat., **58**(2): 257-331.—The most elaborate study made on this continent of this adaptable species.
- LAESSLE, A. M., and O. E. FRYE, Jr. 1956. A food study of the Florida bobwhite, *Colinus virginianus floridanus* (Coues). Journ. Wildl. Mgt., **20**: 125-131.—

- The air-dried, gravimetric percentage of 23 major food items consumed by the Florida bobwhite are presented; these data were based on the examination of 375 crops collected at monthly intervals during a 3-year period. The two principal foods were the fruits of slough-grass, *Scleria muhlenbergii* (26.6 per cent), and wax-myrtle, *Myrica* spp. (15.7 per cent); findings on the nutritional values and consumption preferences of these foods are discussed.—R. F. L.
- LAGLER, K. F. 1956. The pike, *Esox lucius* Linnaeus, in relation to waterfowl on the Seney National Wildlife Refuge, Michigan. *Journ. Wildl. Mgt.*, **20**: 114-124.—Ducklings occurred in only 3 (0.2 per cent) of 1,218 pike, 14 inches or more in length, collected during the 90-day waterfowl brooding season. Predation was not observed when tethered ducklings were placed in natural waters, or when free-swimming ducklings were placed in experimental water enclosures containing pike. Author does not exclude the possibility of considerable duckling mortality through pike predation in waters containing large numbers of pike per unit area.—R. F. L.
- MULLER-USING, D. 1958. Einige Beobachtungen und Feststellungen beim Alpenschneehuhn. (*Lagopus mutus helveticus* Thienemann). *Orn. Mitteil.*, **10**(3): 46-50.—Observations on the Alpine Rock Ptarmigan, regarding weights, food, calls, courtship.
- ROBINSON, T. S. 1957. Notes on the development of a brood of Mississippi Kites in Barber County, Kansas. *Trans. Kansas Acad. Sci.*, **60**(2): 174-180.
- SAKANE, M. 1957. Notes on the Gray-headed Lapwing. *Tori*, **14**(69): 13-17.—Breeding biology of *Microsarcops cinereus* in Japan. (In Japanese; English summary.)
- SCHÄFER, E. 1957. Les Conotos. Etude comparative de *Psarocolius angustifrons* et *Psarocolius decumanus*. *Bonner Zool. Beitr.*, **8**: 1-147. 2 color pls., 49 photos, many drawings.—An elaborate comparative study of two Venezuelan species of large colonial oropendolas. Though one is a subtropical and the other a tropical species, they sometimes were nesting in the same tree. The author studied *P. angustifrons* in greater detail. One female was observed building for five successive years; in the last three years the nest was placed on the same branch, within one meter of its previous location. There is interesting data on the parasitic Giant Cowbird (*Psomocolax oryzivorus*), which the author reports once seeing feed a juvenile of its own species that had doubtless been reared by *P. decumanus*.—E. E.
- SCHEMINTZ, S. D. 1956. Wild turkey food habits in Florida. *Journ. Wildl. Mgt.*, **20**: 132-137.—Thirty-two turkey crops collected on the Florida peninsula between October 1952 and January 1953 were examined; plant materials constituted 97.1 (by weight) of all food eaten. Live oak acorns constituted 48.5 per cent of the total food; grass seeds, *Paspalum* spp., were second in importance (10.3 per cent). Tabulated data from an analysis of 2,775 turkey droppings, representing every month of the year, indicates that plant items constituted 97.0 per cent (by volume) of all food consumed annually; grass leaves were of major importance (21 per cent).—R. F. L.
- SCHWARTZ, P. 1957. Observaciones sobre *Grallaria ferrugineipectus*. *Bol. Soc. Venez. Cienc. Nat.*, no. **88**: 42-62.—An excellent life history account of a hitherto almost unknown Formicariid, the Rusty-breasted Antpitta, with a color photograph of adult feeding nestlings in Venezuela. The author makes the point that at three nests studied, the reaction of adults to human disturbance varied considerably. (In Spanish; English summary.)—E. E.

- SEMONES, V. D., and C. G. CRISPENS, JR. 1956. Three records of male mongolian pheasants incubating clutches. *Journ. Wildl. Mgt.*, **20**: 200-201.—Three male mongolian pheasants (*Phasianus colchicus mongolicus*) were observed incubating small egg clutches in enclosed production units; the number of birds per acre was unusually high. "Broodiness" among the three cocks varied; none completed incubation, nor did any of the incubated eggs show signs of embryonic development.—R. F. L.
- SICK, H. 1957. Rosshaar-pilze als Nestbau-Material brasiliensischer Vögel. *J. f. O.* **98(4)**: 421-431. Horse-hair fungi as nesting material of Brazilian birds. The thread-like mycelia of certain fungi, chiefly *Marasmius*, much resembling horse-hair, are used in nest-building by many neotropical species, of which the author has identified 18 in Brazil. (In German).—E. E.
- SNOW, D. W. 1958. The breeding of the Blackbird *Turdus merula* at Oxford. *Ibis*, **100**: 1-30.—This report is based on study of 59 pairs nesting in four years at the Oxford Botanic Garden. The breeding season lasts from early March to late June. Clutch-size was 3.81 eggs for old ♀♀, 3.38 for young ♀♀; birds of rural, woodland areas have larger clutches than those of the study population in urban parkland. One to four clutches were laid per season, older birds averaging more than younger. Hatching success was more than 90 per cent and was not related to clutch-size. Productivity up to the fledgling stage was 4.1 young per pair per year, and each pair contributed about 1.7 birds to the next year's breeding population. Timing of breeding and clutch-size did not seem to be related to peaks in the abundance of food for the birds.—R. F. J.

#### MANAGEMENT AND CONSERVATION

- GRIFF, J. R., and M. G. SHELDON. 1956. Radio-controlled firing device for the cannon-net trap. *Journ. Wildl. Mgt.*, **20**: 203-205.—Describes equipment necessary for modeling a radio-controlled firing device for the cannon-net trap. Also presents photographs and a schematic drawing of the radio firing device.—R. F. L.
- KLONGLAN, E. D., I. A. COLEMAN, and E. L. KOZICKY. 1956. A pheasant nest activity recording instrument. *Journ. Wildl. Mgt.*, **20**: 173-177.—Describes modification of a temperature recorder into an automatic instrument for recording pheasant nest activity. Resulting data (Iowa) showed that nearly all egg laying occurred between 10:00 A.M. and 3:00 P.M.; incubating hens generally left their nests between 3:00 and 6:00 P.M., with an average absence of about 1 hour. Instances of nest predation were also recorded. Knowledge of the daily periods when most hens are absent from their nest might provide for reduction of mortality among hens nesting in hayfields by selecting timing of mowing operations.—R. F. L.
- ROSENE, W., JR. 1956. An appraisal of bicolor lespedeza in quail management. *Journ. Wildl. Mgt.*, **20**: 104-110.—Data collected in Alabama and South Carolina during a 7-year period showed that, where native bobwhite quail foods were abundant, *Lespedeza bicolor* plantings failed to increase quail populations. Examination of 822 quail crops showed that quail preferred bicolor seeds more than seeds of native plants when both food types were available.—R. F. L.
- TURNER, L. B. 1956. Improved technique in goose trapping with cannon-type net traps. *Journ. Wildl. Mgt.*, **20**: 201-203.—Discusses improvements in techniques of selecting trap sites, placement of traps, baiting, and operation of cannon-type net traps.—R. F. L.

WELLER, M. W. 1956. A simple field candler for waterfowl eggs. *Journ. Wildl. Mgt.*, **20**: 111-113.—Describes use of field candler for determining incubation stages of waterfowl eggs. Discusses and depicts criteria used for age identification of redhead embryos; these criteria are satisfactory for other species with a similar incubation period.—R. F. L.

#### MIGRATION AND ORIENTATION

DOUAUD, J. 1957. Les migrations au Togo (Afrique Occidentale). *Alauda*, **25**(4): 241-266.—In Togo on the Gulf of Guinea, 6° N. Lat., there is a definite influx not only from the Palearctic but also from the tropical areas to the north and south. The migration is chiefly during the dry season, which occurs during the Northern Hemisphere winter. The tropical migrants from the north are rainy season nesters from a more arid region; the tropical migrants from the south (fewer) are mainly transients from a more humid region.—E. E.

ECCLEING, W. J. 1957. Isle of May Bird Observatory and Field Station report for 1956. *Scot. Nat.*, **69**(3): 130-144.—Data on migration, banding recoveries, and other activities.

HARRISON, C. J. O. 1957. Ornithological observations from Lista 1955. *Sterna*, **2**(4): 101-130.—Autumnal migration studies in southern Norway.

HAVERSCHMIDT, F. 1957. The bill color of summering immature Common Terns. *Ardea*, **45**: 176-178.—Five birds taken in Surinam in June and July, 1953 and 1954, with wholly black bills, proved to be immature Common Terns; one of them, taken July 22, 1953, banded as juvenile on June 28, 1951 in Massachusetts, thus confirming that many Common Terns remain south and do not breed until three years old.—E. E.

SCHREIBER, B., T. GUALTIEROTTI and D. MAINARDI. 1956. Risposte differenziali del piccone viaggiatore e normale alla sollecitazione rotatoria. *Boll. di Zool.*, **23**(1): 17-31.—Different responses were noted in the electrical activity of the cerebellum as between homing and ordinary domestic pigeons when subjected to rotation. (In Italian; English summary.)—E. E.

SCHREIBER, B., T. GUALTIEROTTI and D. MAINARDI. 1957. Risposte elettriche cerebellari differenziali a sollecitazioni rotatorie in tortore migrante (*Streptopelia turtur*) e stazionarie (*Streptopelia risoria*). *Istituto Lombardo di Scienze e Lettere, Rend. Sc.*, **91**: 664-671. Milan.—After subjection to rotation the Turtle Dove, a migratory bird, showed characteristic electrical "after discharges" of the cerebellum which were not shown by the Ring Dove, a sedentary bird. The same differences appeared between homing and non-homing domestic pigeons. (In Italian; English summary.)—E. E.

SERVENTY, D. L. 1957. Recovery of a South Australian *Puffinus tenuirostris* in the Bering Sea. *South Austr. Orn.*, **22**(4): 56.—A Short-tailed (Slender-billed) Shearwater, banded as a fledgling in South Australia on March 14, 1957, in its burrow, was taken on May 6, 1957 in the Bering Sea, north of the Aleutians, lat. 50° 40' N., long. 171° 50' E.—a distance of 6,250 miles. As fledglings do not usually leave their burrows until late April, this and two other northern recoveries suggest that the young embark at once on their northward migration.—E. E.

#### PHYSIOLOGY

FRIEDMANN, H., J. KERN and J. H. RUST. 1957. The domestic chick: a substitute for the honey-guide as a symbiont with cerolytic microorganisms. *Amer. Nat.*,

91: 321-325.—Domestic chicks given a diet of finely crushed beeswax mixed with an equal quantity of either *Micrococcus cerolyticus*, *Candida albicans*, or both (cerolytic microorganisms found in the intestine of the Lesser Honey-guide, *Indicator minor*), survived up to 7 or 8 days and actually metabolized the wax, which control chicks without the microorganisms were unable to do.—E. E.

## TAXONOMY AND PALEONTOLOGY

- KEAST, A. 1957. Variation in the Australian Whitefaces (Aves, genus *Aphelocephala* Oberholser, 1899). Proc. Roy. Zool. Soc. N.S.W., 1955-56: 38-42.
- KEAST, A. 1957. Variation in the Bristle-birds (*Dasyornis*) and variation in the Australian Emu-wrens (*Stipiturus*). Proc. Roy. Zool. Soc. N.S.W., 1955-56: 43-52.
- KEAST, A. 1957. Variation and speciation in the genus *Climacteris* Temminck (aves: Sittidae). Austral. Journ. Zool., 5(4): 474-495.—Recognizes six species in three species groups.
- KEAST, A. 1957. Variation in the Australian Kingfishers (Aves: Alcedinidae). Rec. Austral. Mus., 24(7): 61-72.
- KEAST, A. 1958. Variation and speciation in the Australian Flycatchers (Aves: Muscicapidae). Rec. Austral. Mus., 24(8): 73-108.—The various factors leading to speciation and infraspecific variation in Australia.
- LORDELLI, L. G. E. 1957. Duas aves híbridas da fauna do Brasil. Rev. Bras. Biol., 17(1): 139-142.—Reports two fringillid hybrids from São Paulo, Brazil, *Sporophila collaris ochrascens*  $\times$  *S. leucoptera leucoptera* and *Oryzoborus angolensis angolensis*  $\times$  *O. crassirostris maximiliani*. *S. l. leucoptera* was not previously reported from the state of São Paulo. The author says that males of the two species of *Oryzoborus* court females of the opposite species like their own females. (In Portuguese; English summary.)—E. E.
- MAINARDI, D. 1956. Affinità sierologica tra il Cardellino (*Carduelis carduelis* L.), il Lucarino (*Carduelis spinus* L.) e il Fanello (*Carduelis cannabina cannabina* L.). Istituto Lombardo di Scienze e Lettere, Rend. Sc., 90: 122-130. Milan.—Sera prepared against the red cells of the European Goldfinch, Siskin and Linnet indicate that these birds are well differentiated and that the Goldfinch and Linnet show greater serological affinity than the Goldfinch and Siskin. (In Italian; English summary.)—E. E.
- MAINARDI, D. 1957. Affinità sierologiche e filogenesi nei Fringillidi. Rapporti sierologici tra il Verdone (*Chloris chloris*), il Fringuello (*Fringilla coelebs*) e il Cardellino (*Carduelis carduelis*). Archivo Zoologico Italiano, 42: 151-159.—In serological affinity the European Goldfinch seems intermediate between Greenfinch and Chaffinch. Each species has specific antigens, antigens common to all three, and antigens shared with one of the others. (In Italian; summaries in English, French and German.)—E. E.
- MAINARDI, D. 1957. Sulla possibilità di ricavara una serie filetica da dati sull'affinità sierologica ricerche sui fringillidi. Istituto Lombardo di Scienze e Lettere, Rend. Sc., 91: 565-569.—A method is described for indicating diagrammatically serological affinities among species of the same family. Certain serological tests indicate that among four European Fringillidae relationships run in the linear order, Siskin, Linnet, Goldfinch, Chaffinch. (In Italian; English summary.)—E. E.
- MAINARDI, D. 1957. L'evoluzione nei fringillidi. Concordanza fra una "mappa sierologica" e i dati dell'analisi eletroforetica delle emoglobine. Istituto Lom-

- bardo di Scienze e Lettere, Rend. Sc., **92**: 180-186.—Three species of European *Carduelis* and *Fringilla coelebs*, for which a serological chart of relationships was calculated by immunological analyses of the antigens of the red cells, were found to fall into the same order when paper electrophoresis was used to separate two haemoglobins. *Fringilla* is distinguished from the three species of *Carduelis* and four other Carduelines studied by having the electrophoretic trace bands close together instead of separated. It is suggested that *Fringilla* is derived from an early offshoot of the Carduelinae. (In Italian; English summary.)—E. E.
- MILLER, L. and R. I. BOWMAN. 1958. Further bird remains from the San Diego Pliocene. Contrib. in Sci., no. **20**: 1-15.
- NOVAES, F. C. 1957. Notas de ornitologia Amazônica. 1. Gêneros *Formicarius* e *Phlegopsis*. Bol. Mus. Paraense Emilio Goeldi. Zool., no. **8**: 1-9.—The Amazonian forms of *Formicarius* and *Phlegopsis* discussed and a new subspecies, *Formicarius analis paraensis*, described from Pará, Brazil. (In Portuguese.)—E. E.
- PARKES, K. C. 1958. A new race of the Blue-headed Fantail (*Rhipidura cyaniceps*) from northern Luzon, Philippine Islands. Amer. Mus. Novitates, **1891**: 5 pp.—The type locality of *R. c. cyaniceps* is restricted to Mt. Makiling, S. Luzon, and *R. c. pinicola* from N. Luzon is described as new (type from Mt. Benguet). Brief notes on two other races.—K. C. P.
- RAND, A. L. 1958. The races of the bush shrike *Dryoscopus cubla*. Fieldiana Zool., **39**, no. **12**: 87-89.—*Dryoscopus cubla nairobiensis* subsp. nov., from Nairobi, Kenya.—M. A. T.
- RAND, A. L. and D. S. RABOR. 1958. The races of the shrike *Lanius validirostris*. Fieldiana Zool., **39**, no. **11**: 85-86.—*Lanius validirostris quartus* subsp. nov., from Mt. Malindang, Zamboanga, Mindanao.—M. A. T.
- TIMMERMANN, G. 1957. Studien zu einer vergleichenden Parasitologie der Charadriiformes oder Regenpfeifervögel. Teil 1: Mallophaga. Parasitologische Schriftenreihe, **8**: 1-204; 95 text figs. VEB Gustav Fischer Verlag, Jena, Germany.—A study of the mallophaga found on Charadriiformes. The mallophaga known to parasitize this group are first treated by genera, indicating the various birds on which they have been found; then there is a discussion of the phylogenetic implications in each major group of the Charadriiformes, and the affinities of most genera, separately considered. Among the many interesting conclusions drawn from the presence or absence of related mallophaga are: the gull and shorebird groups are so much closer to each other than either is to the auks that two suborders, rather than three, best represent relationships; the turnstones, Arenariinae, belong in Scolopacidae, not in Charadriidae; the dowitchers, Limnodromus, and the godwits, Limosa, are allies, and belong in the Erolinae, not in Scolopacinae or Tringinae; in the Phalaropodidae *Lobipes* and *Steganopus* are nearly related; the Pomarine Jaeger, *Stercorarius pomarinus*, is closer to the Great Skua, *Catharacta skua*, than it is to the smaller species of *Stercorarius*; the skimmers, *Rhynchops*, belong with the Sterninae. (In German.)—E. E.
- VAURIE, C. 1958. Systematic notes on Palearctic birds. No. 32. Oriolidae, Dicruridae, Bombycillidae, Pycnonotidae, Nectariniidae, and Zosteropidae. Amer. Mus. Novitates, **1869**: 28 pp.—Notes on 12 species in these families which are only peripherally palearctic. Detailed reviews of *Oriolus oriolus*, *Hypocolius ampelinus*, *Microscelis amaroensis*, *Pycnonotus leucotis*, and *Zosterops japonica*. Vaurie "sinks" many poorly-defined races (including one of his own),

of which no less than seven were described by Koelz. Recent European literature, including Russian, has been incorporated by the author.—K. C. P.

## MISCELLANEOUS

- BALEARICA, 1: 1-104. 1957. Boletin del Centro de Estudios Ornitologicos Baleares (Colegio Ramiro de Maeztu). Palma de Mallorca. 60 ptas. This is a new journal, to be published annually, dealing primarily with the birds of the Balearic Islands. The first issue contains a number of articles on Balearic birds, including banded birds captured in the Balearics. Articles are in Spanish with English summaries, or in English.
- CONDON, H. T. 1957. Of what value are sight records. *South Austr. Orn.*, 22(4): 42-44. As in America, Australian faunistics are complicated by reports of "bird-spotters." "So long as it is not confused with scientific bird recognition, bird-spotting can be considered a harmless sort of 'game' or sport whose essence is the rapid 'naming' of any bird likely to be met with on a day's outing. The observations are of no value except on those rare occasions when they can be investigated at a later date."
- KURODA, N. 1956-1957. Miscellaneous notes on Anatidae published since 1938. *Tori*, 14(67): 1-14, 14(68): 1-14, 14(69): 1-12.—A useful annotated bibliography of papers on the Anatidae published between 1939-1956. In Japanese, but literature references are given in the original languages; technical names of species treated and localities are also in Latin type.
- MCATEE, W. L. 1957. Folk-names of Canadian birds. *Natl. Mus. Canada Bull.* no. 149: 1-74.—Names (chiefly English or French) used by Canadians of European ancestry are given, with their derivations.—E. E.
- MENGEL, R. M. A catalogue of an exhibition of landmarks in the development of ornithology. From the Ralph N. Ellis Collection of Ornithology in the University of Kansas Libraries. Univ. Kansas Libraries, Lawrence, Kansas. 33 pp.—A useful historical summary of major works from Aristotle to recent writers on the "New Systematics."
- TICEHURST, N. F. 1957. The Mute Swan in England. Its history and the ancient custom of swan-keeping. xiii + 133 pp., 31 pls. Cleaver-Hume Press Ltd., 31 Wright's Lane, Kensington, London W. 8. Cloth 35s.

**NOTES AND NEWS**

Robert P. Allen has been awarded the John Burroughs Medal by the John Burroughs Association for distinguished nature writing, particularly his book "On the Trail of Vanishing Birds."

Ernst Mayr was awarded the Silver Medal of the Linnean Society of London in connection with the celebration of the Darwin-Wallace Centennial by the XVth International Congress of Zoology, held at London in July, 1958.

Roger T. Peterson has been awarded the Geoffroy Saint Hilaire Gold Medal of the Société d'Acclimatation et de Protection de la Nature, leading conservation organization of France, for his work in promoting knowledge and protection of birds, chiefly through his European field guide.

The next International Ornithological Congress will be held in the United States in 1962. Dr. Ernst Mayr will serve as president.

Mr. Francis Hemming, Honorary Secretary to the International Commission on Zoological Nomenclature since 1936, has retired on account of ill-health. Mr. R. V. Melville of the Palaeontological staff of the Geological Survey, London, England, has been appointed Secretary to the International Commission.

**A Reminder: The 1958 A.O.U. Meeting**

The 75th Anniversary Meeting of the A.O.U. will be held in New York on October 14-19. A symposium by leading foreign ornithologists is planned as one of the features.

Those expecting to attend the meeting may be interested in a leaflet, "Birds of the New York City Area" by John L. Bull, just published by the American Museum of Natural History, New York (85 cents).

Members of the A.O.U. are invited by the New Jersey Audubon Society to attend the Annual Cape May Nature Weekend, October 10-13, 1958—the weekend immediately preceding the A.O.U. meeting in New York. Information can be obtained from the New Jersey Audubon Society, Ewing Avenue, Franklin Lakes, N. J.

**Membership List Available**

While they last, members of the A.O.U. may obtain a reprint in pamphlet form of the membership list published in the October, 1957 issue, by writing to the Treasurer and forwarding the price of \$1.00. Membership lists are ordinarily published only at three-year intervals.

The Division of Biological and Medical Sciences of the National Science Foundation announces that the next closing date for receipt of basic research proposals in the life sciences is September 15, 1958. Proposals received prior to that date will be reviewed at the Fall meetings of the Foundation's Advisory Panels and disposition will be made approximately four months following the closing date. Proposals received after the September 15, 1958, closing date will be reviewed following the Winter closing date of January 15, 1959.

Inquiries should be addressed to the National Science Foundation, Washington 25, D. C.

## Editor of 'The Auk':

The difference between species and subspecies leaves much ground for differences of opinion. In the A.O.U. Check-list of North American Birds, Fifth Edition, 1957, species are given English names, but subspecies are not. In previous checklists subspecies had English names and species did not. Those of us who are studying live birds in the field, as well as bird lovers who merely keep lists of the birds they have seen, need English names. Ordinarily they do not need them for subspecies. A Song Sparrow (*Melospiza melodia*), for example, is a Song Sparrow, and the slight differences in coloration and measurements that determine its numerous subspecies do not concern the field student.

The two species of Meadowlarks (*Sturnella magna* and *S. neglecta*) would probably be considered only subspecies if the songs and call-notes were not so different and so noticeable. The same is true of the Eastern and Western Wood Pewees (*Contopus virens* and *C. sordidulus*). The Yellow-shafted and Red-shafted Flickers (*Colaptes auratus* and *C. cafer*) are different in plumage, but, in my experience, not different in call-notes, song or courtship habits. But they are considered distinct species and the intermediate individuals are considered hybrids.

The eastern and western forms of the Rufous-sided Towhee (*Pipilo erythrourus*) differ very much in both plumage and song, but are now considered to be one species. Intermediate birds are deemed not hybrids, but intergrades. Any bird student acquainted with only one form of this species, but wishing to know the marked difference should consult Pough (Audubon Bird Guide to Eastern Land Birds, 1946) and look at plate 37. Anyone who wishes to know the difference in songs and calls must go where the live birds are found and listen to them, for bird skins do not sing (Saunders, 'The Relation of Field Characters to the Question of Species and Subspecies,' *AUK*, 53: 233).

Whether the eastern and western forms are two species or one is a matter of opinion, but because they are distinguishable by sight and sound in the field, we need distinctive English names, such as Eastern Towhee and Spotted Towhee. There are other borderline cases, such as that of the Red-breasted Sapsucker (*Sphyrapicus varius ruber*), treated as conspecific with the Yellow-bellied Sapsucker (*S. v. varius*). These are different from the Song Sparrow, whose subspecies cannot be definitely distinguished by field observers.

ARETAS A. SAUNDERS

Canaan, Conn., May 21, 1958.

**Ed. Note:** Most students agree that the A.O.U. Check-list Committee effected a useful reform in providing English names for species, rather than for subspecies. At times it would certainly be convenient to have an A.O.U. vernacular for a distinctive form (or groups of forms), currently treated as a subspecies, about whose specific status there is uncertainty or substantial dispute. One can see, however, that the Committee might have encountered considerable disagreement in deciding which forms fell within that category, and, as a matter of policy, the Committee wished to place emphasis on the species entity. After all, the technical names are available, and one can always use a geographic or descriptive designation to make distinctions between populations.

Frontiers of Science Foundation of Oklahoma, Inc., Republic Building, Oklahoma City, offers research grants to investigators in the fields of natural sciences and science education working in Oklahoma.

Yale University is erecting a new building to house the Yale Ornithology Laboratory, including the William Robertson Coe Memorial Ornithology Collection. Occupancy is expected by January, 1959.

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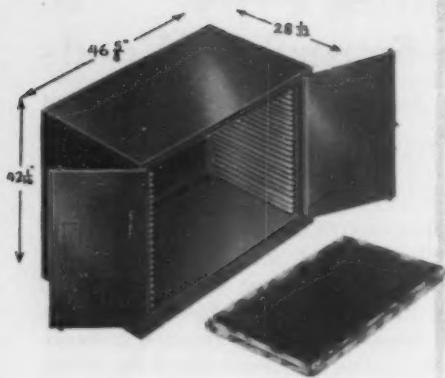
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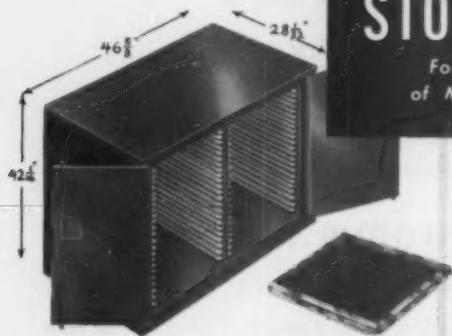
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Proofs of all articles and notes will be sent to authors. Reprints from articles, 'General Notes,' and 'Correspondence' are to be paid for by the author. These must be ordered from the Editor on the blanks sent with the proof and must be returned with the proof. Printed covers can be furnished at additional cost.

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EUGENE EISENMANN, *American Museum of Natural History, Central Park West at 79th Street, New York 24, New York.*

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